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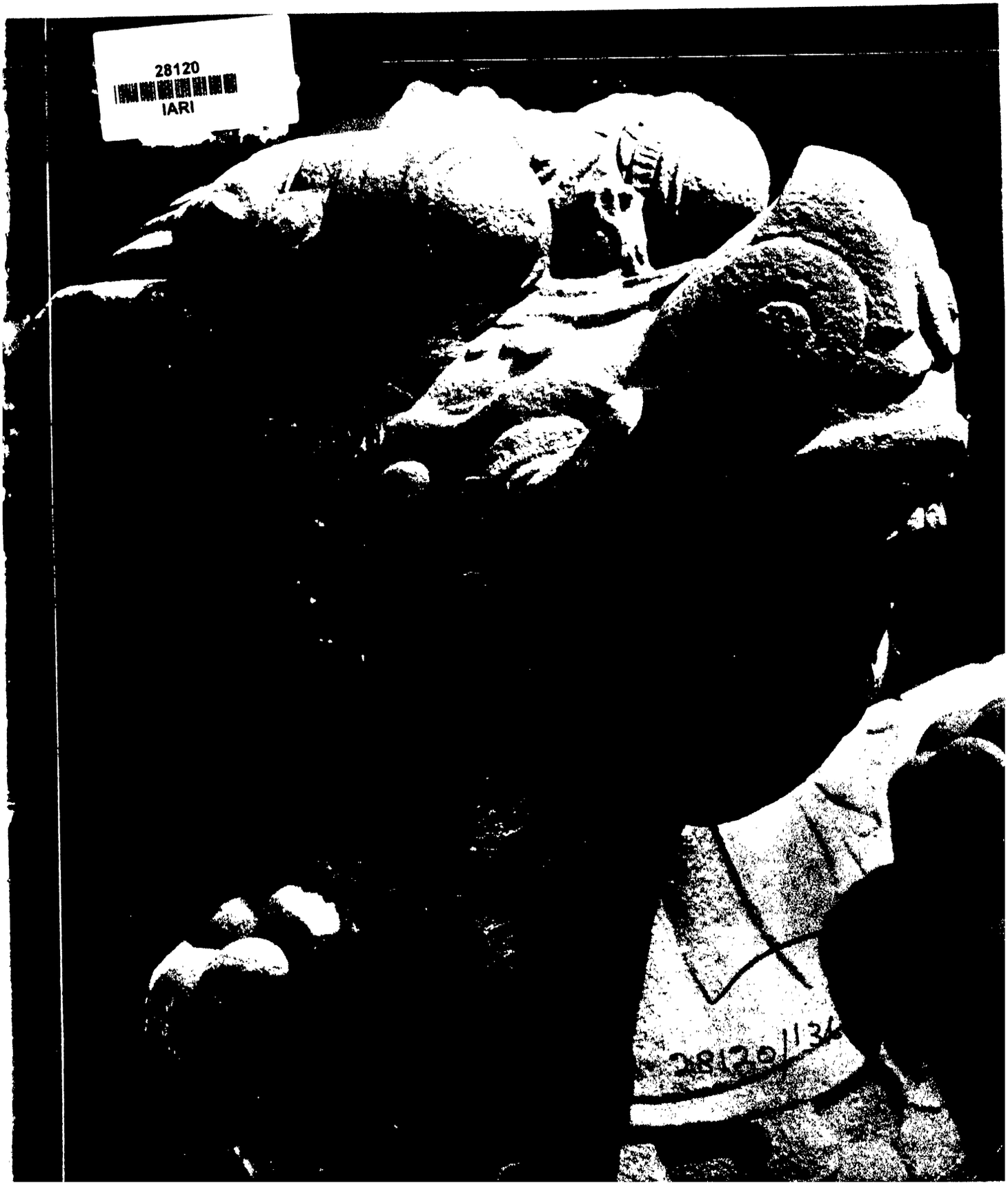

A Personality, A Promise, An Invitation

To Readers of Scientific American:

PROFESSOR Alexander Klemin needs no introduction to old readers of Scientific American, who have benefited by his regular monthly contributions as associate editor for the past 10 years. It seems fitting to remind readers both old and new of the wealth of knowledge and experience that lies behind every sentence that Professor Klemin writes, for even a casual examination of his distinguished record amply proves his unique equipment to compress years of research, knowledge, and experience into a brief paragraph or even a single sentence.

Relying upon the helpful co-operation of our contributing editors, our Editor, Orson D. Munn, with the able assistance of the staff, each member of which is a distinguished specialist in his field, promises a dynamic, vital, and helpful editorial program for the coming year.

A significant example of the timeliness of our editorial coverage, was the publication of articles on cosmic rays in our September, 1935, issue, research on these mysterious rays from outer space being the primary purpose of the stratosphere flight from the hills of Dakota scheduled for early fall. Although the successful flight of Captains Stevens and Anderson was delayed, our readers received, three months prior to the actual achievement, the background information on cosmic rays. When the new information, secured through the successful venture, is scientifically evaluated, our readers will be informed of the result.

Our Research-Leaders-Help-Us-Edit program for 1936 assures the reader that no important development in research and science will escape his attention. You, too, can help us edit, by suggesting subjects that you would like to have included.

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EVERY significant scientific discovery or laboratory development is immediately recorded and evaluated. This editorial service is not for the specialist in a particular field, but for all research men in industry, for research students in school, college, or university, and for that select group of science-minded individuals who cherish accurate scientific knowledge for its own sake.

Measured in numbers, the readership of Scientific American is not large, and never will be large. Its editorial standard is too high either to appeal to or to be appreciated and understood by the mass mind, yet the Scientific American readership, in its influence and purchasing power, is an unexploited and unused market for many advertisers desiring to reach those who pioneer in Commerce, Industry, School, and Government.

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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COVER

FRENCH archeologists in Annam, a part of Indo-China, recently excavated a number of striking sculptures which were found to belong to a civilization of Hindu origin which existed in that country and dated back almost to the beginning of the Christian era. One of these sculptures, shown on the front cover, was an architectural decoration and has a dragon mask. The length of the sculpture is 66 inches. Further details of the excavations are given on page 4.

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50 Years Ago in . . .

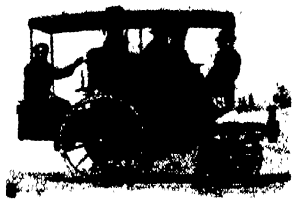
Scientific American

It is frequently the case that present-day advances in science and industry can be more fully appreciated when there is available some knowledge of what has gone before. The accompanying excerpts from Scientific American for January 1886 were selected from our files for their inherent interest and significance. If you would like to see this page continued as a regular feature of Scientific American, won't you write us a note to that effect?

ORSON D. MUNN, *Editor and Publisher*

DON'T BLOW OUT THE GAS! "A new device is designed to prevent all danger arising through the ignorance or carelessness of persons who blow out a gas jet. By means of a simple contrivance, which is reliable in its action and is operated by the force of the wind necessary to blow out the light, the cock is turned and the supply cut off."

STEAM CARRIAGES—"Street locomotion by steam has just made a great stride in the domain of practice. Messrs. Dion, Bouton & Trepardoux have succeeded in manufacturing steam vehicles of all sorts and of all dimensions from the tricycle up to the largest omnibuses and merchandise vans. This result is the outcome of their quick-vaporizing, circulatory, inexplosive boiler, which is applicable to all the industries in general."



ARTIFICIAL LEATHER "Artificial leather is, according to a French invention recently patented, made by a cotton fabric, the warp threads of which are very slightly twisted, and the weft threads of which are finer than usual. This fabric is serrated on both sides, and immersed in a preparation consisting of a decoction of linseed, rabbit skin glue, linseed oil, and coloring matter."

ELECTRIC RAILWAY—"The city of South Bend, Ind., has introduced an electric street railway. The system in use, the Van Depoele railway, has been in successful operation at Toronto, Canada, for the past two years, and it is expected to be introduced shortly into Minneapolis and Detroit. The railway at South Bend is operated by an electric current transmitted by overhead wires."

GLASS FLOORS—"The substitution of glass flooring for boards continues to increase in Paris, this being especially the case in those business structures in which the cellars are used as offices. At the bank of the Credit Lyonnais, the whole of the ground in front is paved with large squares of roughened glass embedded in a strong iron frame, and in the cellars beneath there is sufficient light, even on dull days, to enable clerks to work without gas."

MECHANICAL HORSES—"*Chamber's Journal* mentions a gentleman who, being prevented, by physical disqualification, from continuing the exercise on horseback which had always been so beneficial to his health, was possessed with the singular notion that it would be possible to construct a machine which, when seated upon, could be made to evolve the same action as a galloping horse. The inventor made his machine; it answered its purpose to his complete satisfaction; and the device having been patented, it has recently been manufactured and brought before the public."

PHONING TO SHIPS—"For the last eight months the Telegraph Construction and Maintenance Company has had several of its best operatives located in the neighborhood of the Naze, off which the most dangerous sands round England are to be found. These gentlemen are hourly in communication by telephone with a lightship which is anchored ten miles out, in the vicinity of the Swin passage. It was considered improbable that the human voice would be conducted ten miles, especially in rough weather; but this has been now proved to be thoroughly practicable."

LELAND STANFORD JR. UNIVERSITY "Senator Stanford, of San Francisco, has executed a deed of trust by which lands and funds to the value of $20,000,000 have been devoted to the establishment of a great university at Palo Alto, Cal."

KEELY MOTOR "One of our contemporaries reports that Isabella, ex-Queen of Spain, is not only an owner of considerable real estate in Philadelphia, but is a shareholder in the Keely motor. From the same source we learn that the motor Keely promises positively to mote very soon, but it begins to be believed that his mote is the much-quoted one which is all in his eye."

INSECT TRAPS—"During the past summer the insect destroyer shown in the accompanying engraving gave most satisfactory results during thorough and practical tests by the inventor, Mr. Dudley H. Manning, of Sibley, Iowa. The under surface of the conical top, through the center of which the chimney passes, is bright, as are also the partitions that extend inward from the upright of the frame and carry the socket for receiving the lamp."

AUTOMATIC STEERING—"The old war vessel *Tallapoosa*, which has been undergoing a thorough overhauling at the Brooklyn Navy Yard, has among other improvements been supplied with an electrical steering apparatus, by which the ship guides her own course automatically. The automatic action is obtained by means of an electrical mechanism, which is attached to the compass."

GRASSHOPPERS "It is reported that the citizens of Helena, Arkansas, were recently aroused early in the morning by what seemed to be a heavy rainstorm, but they found the sky perfectly clear, and the air full of dark flakes which afterward proved to be a cloud of grasshoppers. They pattered against the roofs and windows of the houses in large numbers."

HEARING AID—"A prize is offered, of 3000 francs, by Baron Leon de Lenval, of Nice, France, for the best readily portable instrument constructed according to the principle of the microphone, for improvement of hearing in cases of partial deafness."

AND NOW FOR THE FUTURE

¶ The Carbon Monoxide Danger in Driving Automobiles, by Prof. Lawrence A. Clousing. How to Avoid it.

¶ High Voltage Experiments that May Have a Definite Effect on Power Transmission, by Andrew R. Boone.

¶ A Pure Science Article by Prof. E. U. Condon, on the Conversion of Matter into Energy.

¶ American Archeology — The Great Serpent Mound in Ohio, by Capt. Dache M. Reeves.

¶ Radium from the Arctic Used in the Fight Against Cancer, by James Montagnes.

Personalities in Science

© Bachrach

MAJOR EDWIN H. ARMSTRONG

MAJOR Edwin H. Armstrong, professor of electrical engineering in Columbia University, recently gave the first public demonstration of his new staticless radio system before the Institute of Radio Engineers, which in 1917 awarded him its medal of honor for "engineering and scientific achievements in relation to regeneration and the generation of oscillations by vacuum tubes."

Born in New York City on December 18, 1890, Major Armstrong commenced research with the vacuum tube during his freshman year at Columbia in 1908. In 1912, while still an undergraduate, he invented the regenerative circuit for high frequency oscillations, which revolutionized radio transmission and receiving apparatus and is the basis of modern radio. He was graduated from Columbia with the degree of Electrical Engineer in 1913. In 1929, Columbia conferred upon him the honorary degree of Doctor of Science.

Twenty-one years of effort to achieve a radio system devoid of static began in April, 1914, when Major Armstrong started investigations with the late Prof. Michael I. Pupin in the Marcellus Hartley laboratories of Columbia University. In April, 1935, Major Armstrong announced that he had successfully developed an ultra short-wave frequency modulation system which eliminates static, fading, and tube noises.

Major Armstrong invented the superheterodyne, universally used in broadcast reception, while serving overseas in the Signal Corps of the A. E. F. during the World War. After the War he continued his work with Prof. Pupin until 1922. In 1920 he discovered the super-regenerative circuit, which is widely employed in ultra short-wave police communication, in airplane equipment, and in amateur communication.

By 1922, Prof. Pupin and Major Armstrong felt that they had exhausted every possibility. Prof. Pupin turned to other investigations, but Major Armstrong continued to devise new theories and to prove each of them wrong. The first glimmering came in 1924. After years of work following that lead, he arrived at the theory of frequency modulation. Major Armstrong estimates that for this period of investigation between 50,000 and 100,000 measurements are now preserved in records. The work came within the class once described by Thomas A. Edison as "10 percent inspiration and 90 percent perspiration." Success was not due to any brilliant idea suddenly plucked out of thin air, but to painstaking experimentation which frequently required a set-up in which more than 100 vacuum tubes operated at one time, and the use of every measuring instrument known to the radio art.

The key discovery of the new system consists in introducing into the transmitted wave a characteristic which does not exist in the waves produced by nature. A receiving system is then used which is not responsive to waves of natural origin, but only to the waves having the special characteristic.

Besides discovering the essential principle of the new system, Major Armstrong had to invent numerous pieces of apparatus to put it into working shape. The system will principally be used in ultra-short and micro-wave signalling, as the frequency band required is greater than may be used on the normal broadcast wavelengths. The band width used at present on seven meters is about 150,000 cycles.

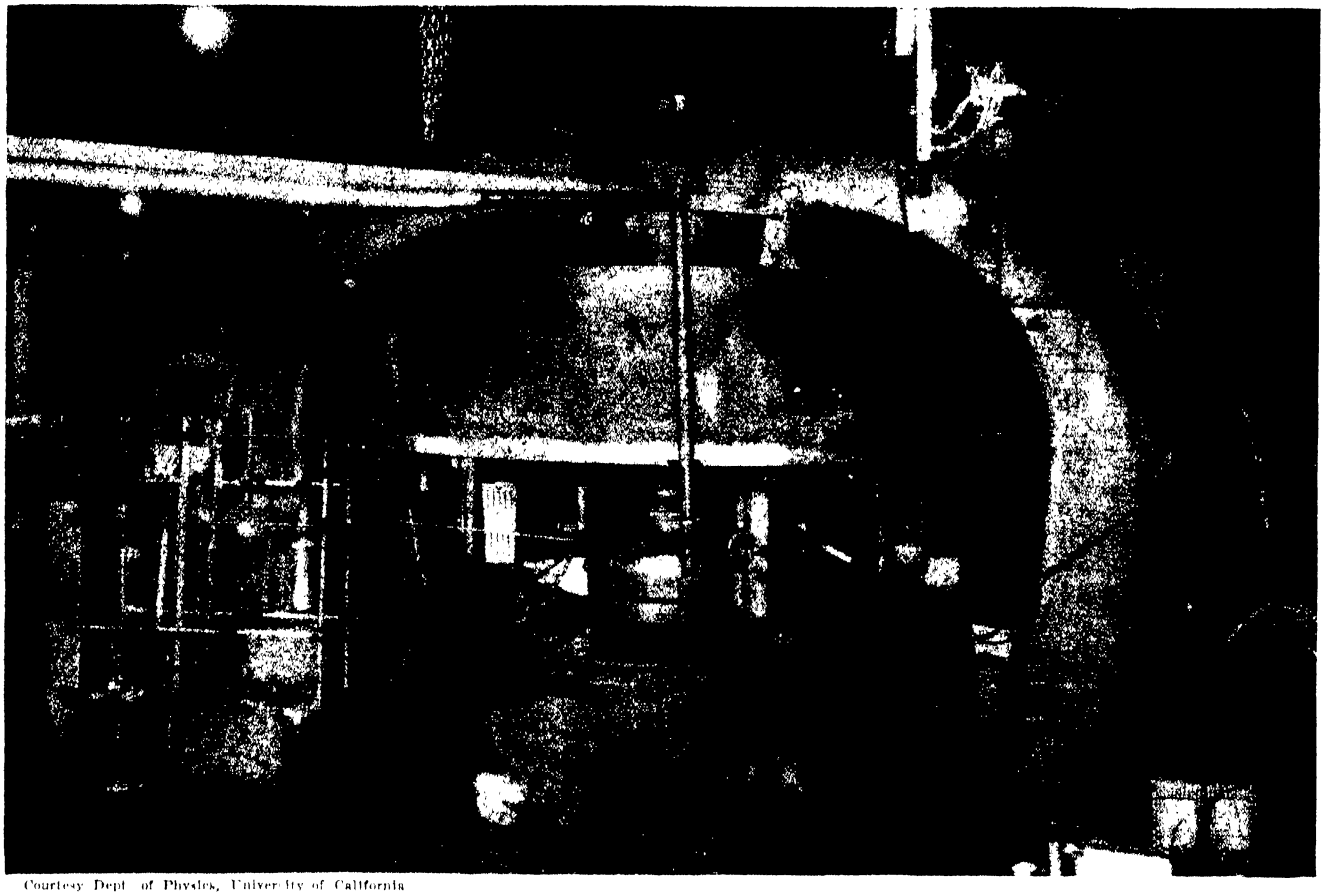
Frequency modulation is diametrically opposed to amplitude modulation, now used in broadcasting. With the special arrangements of the Armstrong system, static will not affect it even when lightning strikes within the immediate vicinity of the antenna. More than one program can be simultaneously transmitted, using one transmitter and one receiver. Facsimile copies of printed matter have been transmitted on the same wavelength simultaneously with a musical program. Receivers must be especially designed for the system. Selective fading, causing musical instruments to produce strange noises, and speech to become unintelligible, is non-existent.

ANCIENT ART REVEALED BY A PEASANT'S PLOW

EAST of India, and occupying the Indo-Chinese Peninsula south of China, lie three countries, Burma, Siam, and French Indo-China. The coastal strip of French Indo-China, along the South China Sea, is Annam. Before the French conquest (1884), Annam was a self-ruled empire, and before the time of that empire there was another empire, the Kingdom of Champa. Inscriptions discovered by the French have indicated that this Cham Empire, of antiquity about equal to that of the Christian Era, was of Indian origin, for the inscriptions were in Sanscrit. How this first civilization in Annam spread there from India, which is 1400 miles air-line distance and 3000 miles by sea—the only practicable route—is a question in itself. Recently a peasant in Annam, while plowing, struck on a stone which obstructed his plow, and he therefore stopped to dig it out. The "dig" proved longer than he anticipated: for the stone was the upraised trunk of the stone elephant shown in the illustration at the left, seven feet in height. Agitated and fearing reprisals from the spirits of the Beyond, according to Jean Yves Claeys, Inspector of the Archeological Service of the French School of the Far East, who gives the account in the *Illustrated London News*, he rushed to the mandarins, and thus the archeologists got wind of the find. It dates from somewhere between the 11th and the 15th Centuries.

Left: **The stone elephant, after excavation**

Below: **Excavating other sculptures nearby**



Courtesy Dept. of Physics, University of California

The 80-ton cyclatron of Prof. Ernest O. Lawrence of the University of California. It consists essentially of an immense electro-magnet, between whose large pole pieces there is a large, flat, vacuum tank. In this circular tank ions are set in motion and kept whirling in a circular path by the magnetic field, at each revolution gaining velocity. Finally they are flung with immense speed and terrific energy at the chosen targets. The effect is equal to that given by a potential difference of 2,000,000 volts, and the apparatus is used in connection with the atomic research described by Professor Condon

ARTIFICIAL 'RADIUM'

Making Other Elements Artificially Radio-Active . . . What Happens . . . Central Importance in Physics Today . . . Treatment of Cancer

By E. U. CONDON
Associate Professor of Physics, Princeton University

RADIUM is the best known of a group of chemical elements, known as the radio-active elements, which have the property of spontaneously emitting various kinds of radiation in the process of an atomic disintegration. The radiations emitted, especially the gamma rays, have proved useful in the treatment of cancer. These naturally occurring radio-active substances are of great rarity and consequently of great expense. Therefore the recent discovery of means of making other elements artificially radio-active marks an advance in physics which may easily prove to be a great boon to medicine.

By writing "radium" instead of radium in the title, it was intended to indicate that what is now being produced in the physical laboratory artificially is not the chemical element radium, but artificially radio-active substances which have in common with radium the property of spontaneously emitting the radiations which are known to have therapeutic value.

The important discovery that matter may be made artificially radio-active is an outgrowth of the great burst of experimental discoveries that have been made in the physics of the atomic nucleus within the past five years. First publication of the discovery was made on January 15, 1934, by Irène Curie, daughter of the famous discoverer of radium, and F. Joliot, her husband. For this discovery they were awarded the 1935 Nobel Prize in chemistry. Since their pioneer work, others have extended and confirmed the original observations, so that studies on artificial radio-activity now form an important part of the research program of a number of leading laboratories of the world. Especially noteworthy in the subsequent developments has been the work of Enrico Fermi and collaborators in Rome, of Lord Rutherford and his co-workers in Cambridge, England, and of Ernest Lawrence at the University of California in Berkeley.

In order to get a clear understanding

of the recent discoveries it is necessary to recall a little of the general picture of the structure of the atom as revealed by physical research in the 20 years since Bohr built his atomic theory on the picture of the nuclear atom as developed by Lord Rutherford. According to this picture, every atom is constructed out of a central massive part called the nucleus, surrounded by one or more small units of negative electricity called electrons. The nucleus carries a charge of positive electricity, so that the whole atom is electrically neutral. Different chemical elements are characterized by having different numbers of electrons around the nucleus: the number of electrons around the nucleus of an atom is called its atomic number. The arrangement and behavior of these electrons is almost entirely responsible for the chemical properties of the atom, and great progress in understanding just how these electrons behave in the formation of chemical compounds has been made since the discovery of the principles of wave or quantum mechanics ten years ago. Chemical elements are known corresponding to atomic numbers up to 92, which is uranium, although a great many of the elements are very rare. The ones which are naturally radio-active correspond to the large values of the atomic number; thus uranium is radio-active. But the ones which play a prominent part in current researches on nuclear physics are those of low atomic number, for a reason that will be brought out later. For that reason, and to fix the ideas, it is convenient to have at hand the following short list of the elements of low atomic number:

Name of element	Number of electrons outside nucleus	Chemical Symbol
Hydrogen	1	H
Helium	2	He
Lithium	3	Li
Beryllium	4	Be
Boron	5	B
Carbon	6	C
Nitrogen	7	N
Oxygen	8	O
Fluorine	9	F
Neon	10	Ne
Sodium	11	Na
Magnesium	12	Mg
Aluminum	13	Al
Silicon	14	Si
Phosphorus	15	P
Sulfur	16	S

IN the last column is given the abbreviation by which chemists refer to these various elements. Every one of these elements, it will be noticed, is one of fairly common occurrence and well-known in daily life.

Thus the number of electrons outside the nucleus is definitely correlated with the nature of the chemical element. But there is a way in which different atoms of the same element may differ; namely, in the mass or weight of the nucleus. On the whole the different masses of atoms of the same element usually do not differ a great deal, and the chemical behavior is only slightly influenced by the mass of the nucleus anyway, so for most of chemistry it is not important to distinguish between the different *isotopes,* which is the technical name for the elements of like atomic number but differing atomic weight. However, a difference in mass means a different structure to the nucleus, and so different isotopes must be counted as different substances altogether, when we are interested in the structure of the nucleus of the atom. The most striking case in which the chemical behavior of two isotopes is appreciably different is that of hydrogen. The rare isotope, of mass twice that of ordinary hydrogen, is sufficiently different in its chemical properties, so that the gas of such atoms has been given a special name, deuterium. The discovery of this isotope of hydrogen, for which Professor H. C. Urey of Columbia University was awarded the Nobel Prize in chemistry in 1934, has proved of great importance both in purely chemical studies and also in research on the physics of the nucleus.

Most of the progress in atomic physics up to five years ago was concerned with the behavior of the electrons around the nucleus, and very little progress was made in understanding the structure of the nucleus. In view of the complexity of the problems presented, it was indeed fortunate that the general problem of atomic structure could be thus dissected into two quite separate parts, the physics of the outer structure and the physics of the nucleus. Although a great deal of information about nuclei, especially of radio-active elements, was amassed by researches since the discovery of radium about 40 years ago, the modern period of study of the nucleus may be dated from the Fall of 1928.

AT that time the first essential application of the wave mechanics to a problem of nuclear structure was made to give an account of the way in which radio-active elements spontaneously disintegrate with the emission of high speed helium nuclei. This was done simultaneously and independently by R. W. Gurney and E. U. Condon at the Palmer Physical Laboratory of Princeton University, and by G. Gamow, then at Göttingen, Germany, now a professor at George Washington University in Washington, D. C. This work made it clear that, in disagreement with previous ideas of mechanics, it is easier for particles to go in and out of nuclei than had been supposed. The success of the theory in explaining some important features of natural radio-activity at the same time made it clear that production of nuclear changes by bombarding materials with high energy electrical particles might go more readily than had been supposed. Up to that time it appeared that the bombarding particles would have to be given energy by the application of potentials of many millions of volts. The quantum mechanical work indicated that much lower voltages would suffice to produce results.

Courtesy Massachusetts Institute of Technology

The high-voltage electrostatic machine developed by Dr. R. J. Van de Graaff and set up near New Bedford, Mass. It will give a 10,000,000-volt potential to be used for bombarding atomic nuclei

Shortly thereafter began the great program of bombarding matter with high energy particles, which has been thus far the principal mode of research on the physics of the nucleus. The general method is to produce a beam of ions, let us say of hydrogen or deuterium. The ions are atoms which have lost one or more electrons by a proper kind of impact of the kind akin to those occurring in ordinary neon lamps or in the sparks of an automobile ignition system. Being now electrically charged, if these ions are introduced into a space where there is a high voltage, they will be acted on by electrical forces and acquire great speed, hence great momentum and energy. Such a beam of swiftly moving ions is made to strike against a target of the material under investigation. What happens? It is known that the nucleus has a diameter only about one ten-thousandth of the diameter of the whole atom. As individual atoms in the target are so small that there can be no hope of aiming at the nucleus, it follows that a great many of the high speed ions rush into the target without getting extremely close to any atomic nucleus. As they penetrate the target they mix with the outer electrons of the matter, and so lose their energy and are brought to rest. Thus the great majority of them are brought to rest without ever having an intimate encounter with the nucleus of any atom in the target.

Those ions which happen to be headed fairly directly at a nucleus will tend to come close to it, although this tendency is reduced by the fact that there are electrical forces of repulsion between the ion and the nucleus, as both are charged with like kinds of electricity. This repulsion bends the path of the ion away from the nucleus. But naturally this effect is smaller the greater is the energy of the ion—that is, the greater the voltage of the electrical apparatus with which the ions have been given their energy. It is also smaller for the elements of low atomic number, which is the reason most researches have thus far been made with these elements. So a certain very small fraction of the ions makes a really close and intimate collision with one of the nuclei of the target, perhaps one in 10,000,000 or 100,000,000. What happens in the case of these very few impacts is the object of study.

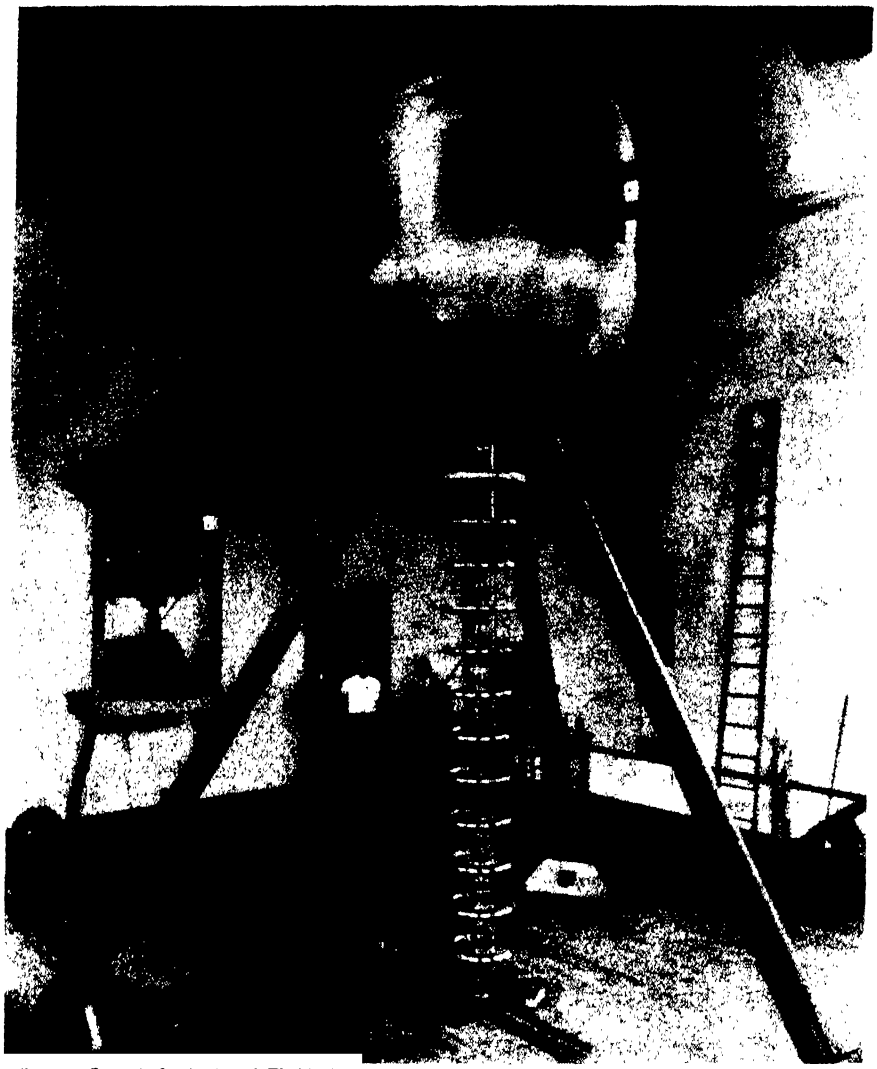
In the different laboratories different methods are used for obtaining the high voltages necessary. Probably the most ingenious and fruitful of these is that developed by Lawrence at Berkeley, in which the ions are made to be accelerated again and again by the same electric field and so the effect of having 2,000,000 volts is produced, even though but 10,000 is used. Now that the Lawrence "cyclatron" is in regular operation, Berkeley has become the leading center of research in nuclear physics in America. Another important method is the high voltage electrostatic machine developed at Princeton by Dr. R. J. Van de Graaff. This has been fruitfully adapted to research on nuclear physics by Dr. M. A. Tuve at the Carnegie Institution of Washington. Meanwhile Van de Graaff has devoted his attention to the development of an extremely large apparatus of this kind at Round Hill, Massachusetts, for the Massachusetts Institute of Technology, which when brought into operation on nuclear physics problems ~~will~~ provide much higher voltages than any yet used.

SO much for a brief outline of the general method. What are the results? The results, all accumulated in the last three or four years, are that artificial transmutations of elements, through changes in the nuclei of the elements, are now being produced and studied regularly in a number of physical laboratories throughout the world. Many of these transformations are accompanied by the release of large amounts of atomic energy, in which the actual mass of matter is transformed into energy of motion of the particles produced. Such a possibility was first predicted theoretically by Einstein as long ago as 1905. There is no hope as yet of actually developing these processes as a source of power because of the infrequency of successful hits, as already mentioned. Although in the case of a successful hit the amount of energy released is often great compared with the energy of the single ion which causes the transformation, so much energy is wasted in accelerating the many particles which do not make a hit that, on the whole, much more energy is put into such an experiment than can be taken out of it. Also at present there is no known way of getting out the released energy in a useful form.

Among the atomic transformations so produced there are a number which go to completion slowly; that is, they exhibit the phenomena of radio-activity. The first example of this kind was discovered by Curie and Joliot, as already mentioned. They bombarded several elements, among them aluminum, with high energy helium nuclei as obtained from a naturally radio-active substance. It had been known before that this resulted in the production of various radiations from the aluminum target. The new discovery consisted in the observation that the aluminum target continued to send out a radiation of high energy particles for several minutes after the bombardment stopped. Investigation showed that the aluminum was sending out high energy positrons. Positrons are a new type of electrical particle discovered in September, 1932, by Dr. Carl D. Anderson at the California Institute of Technology in Pasadena. (See article on positrons in Scientific American, August, 1935.) They are like electrons, in that their mass is small compared with that of an atomic nucleus, but carry a positive electrical charge instead of a negative, as does the electron.

BY standard methods of chemical analysis it was revealed that what happens in the case of aluminum bombarded by helium nuclei is this: the helium nucleus may be captured by the aluminum nucleus with the emission of a neutron. Neutrons are particles, also first discovered in 1932, through the interpretation by Dr. J. Chadwick of Cambridge, England, (for this Chadwick has just received the 1935 Nobel Prize in physics) of experiments made by Irène Curie and F. Joliot. They have no electrical charge but have a mass about the same as that of a hydrogen atom. In consequence, the resulting nucleus has two more charges than the original aluminum nucleus and hence must be phosphorus, as reference to the list given earlier in this article shows. But on checking up the masses involved (four units added by the helium and one taken away by the emitted neutron) the atomic weight of the phosphorus nucleus produced would be three more than that of the original aluminum nucleus, or 30. Such a phosphorus nucleus was hitherto unknown, and the reason is now obvious, for these researches show that such a nucleus is unstable and spontaneously disintegrates in a few minutes, emitting a positron with consequent production of a nucleus having one unit less of nuclear charge, hence being number 14 in the list; that is, silicon. The silicon produced is stable, and nothing further happens to it.

This instance is typical of the kind of transformations involved in at least a dozen instances which have been studied since the original discovery of Curie and Joliot. Later work by Cockroft, Gilbert, and Walton in Cambridge, by Crane and Lauritsen in Pasadena, by Tuve and Hafstad in Washington, and by Law-



Courtesy Carnegie Institution of Washington

Another form of the Van de Graaff electrostatic machine, adapted to research on nuclear physics by Dr. M. A. Tuve of the Carnegie Institution of Washington

rence, Henderson, McMillan and others at Berkeley, have shown that similar artificial radio-active substances may be produced by bombarding targets of various materials with high energy nuclei of hydrogen and deuterium obtained by accelerating the ions with high voltages as already described. Among these, the result of bombarding sodium by high speed deuterons is of particular interest. Deuteron is the name for the nucleus of the rare hydrogen isotope, deuterium. This was studied in detail by Lawrence at Berkeley.

In this case there is ample evidence that the deuteron is captured by the sodium nucleus in the case of successful hits, and a proton (nucleus of ordinary hydrogen) is emitted, leaving the resultant nucleus heavier by one unit than before but with the same electric charge, so it is still sodium. The resultant nuclei are radio-active and continue their activity for a much longer time than in the case of aluminum bombarded by helium nuclei. Another important feature of the radio-sodium so produced is that it emits a high energy gamma radiation; that is, a radiation of the same character as the X rays which would be produced if an X-ray tube could be operated at about 5,000,000 volts. This type of radiation is known to have important therapeutic action in the treatment of cancer, and already experiments using radio-sodium are in progress at Berkeley. Every effort is being made to increase the voltage and the current of ions bombarding the sodium target, in order to produce larger supplies of this material.

The way in which the activity of these substances dies out is by a law of geometrical progression. In the case of radio-sodium it is half gone in 15 hours, one fourth remains after 30 hours, one eighth after 45 hours, and so on. In consequence it was possible last April for Professor Lawrence to have his colleagues at Berkeley prepare some radio-sodium and send it to him by airmail for demonstrations of its properties before the physical colloquium at Princeton and elsewhere in the East.

Another important property of these artificially radio-active materials with regard to possible medical applications is that, except for their radio-activity, they are chemically like the ordinary material. Radio-sodium may therefore be injected into biological materials without fear of biochemical complications, for sodium is a constituent of common salt which occurs in all biological fluids. Moreover, its radio-activity is completely gone in a few days, so that dosage will be easily controlled. Still another point deserves mention in this connection: with the possibility opened up of producing radio-activity artificially in a large variety of chemical elements, it may prove possible to utilize the ordinary chemistry of the material to put the radio-active material where it is most needed in the organism. Thus phosphorus concentrates in bone tissue, so treatment with artificial radio-phosphorus would be indicated where it was desired to apply the radio-active radiations to such tissue.

Too much must not be expected right away from the biological applications, however. It must be remembered that the whole effect has not been known for more than two years and that, as yet, the means for producing these interesting new materials in quantity are completely lacking. Several years more of intensive work will probably do much toward extending our knowledge of the physical conditions necessary for production of these radio-active elements. In the meantime some biological study can be made with the small quantities available, pending the time when physicists will be able to produce better supplies of the new substances.

NATURALLY these developments occupy the place of central importance in physics to-day, and laboratories everywhere are equipping themselves to take part in the detailed studies which have yet to be made, just as several decades ago they were concentrating their resources in an attack on the outer structure of the atom. Several eastern laboratories, including Princeton, Rochester, Cornell, Columbia, Michigan, and the Bartol Research Foundation at Swarthmore, now have under construction apparatus of the Lawrence type for producing high energy ions, so we may look forward to an accelerated progress of studies in this field.

Curiously enough the total cost of all this work is probably well under 100,000 dollars, yet in spite of its great potential value to humanity, nothing has been contributed to its support by our government at a time when billions are being spent on all sorts of strange and uncertain projects. The principal "contribution" to research in physics which has been made by the present administration, so far as I am able to learn, has been a drastic cut in the appropriation for the work of the Bureau of Standards, whereby its work in physics has been quite effectively curtailed.

OUR POINT OF VIEW

Death and the Motor Car

IT seems that the active campaign against automobile accidents which has been carried on through the editorial pages—this one included—of many periodicals throughout the country, is beginning to bear fruit. So grave is the situation, even with the progress which has been made, that we feel justified in surveying the entire subject here, and once more dwelling on the factors that must be improved.

When considering motor-car safety—or, rather, lack of safety—it is necessary to subdivide the whole subject into three general divisions. The driver, the car, and the highway must be considered as separate entities. True, the consideration must overlap at times, and frequently the three units must be treated as one, but if they are kept in mind as individual factors, it will aid in clarification.

The driver of a motor car is the only part of the trinity endowed with a mind. He has the power to think, to direct the operation of his vehicle. If he, as the thinking link of the chain, fails, all else fails. If our highways are to be safer and motor-car accidents are to be reduced, one of the definite points of attack must be the driver. Human nature being what it is—rugged individualism, personal rights, and what-not complicate the picture—the problem becomes involved. Standing on what he considers to be his "rights," the driver naturally resents any implication that *he* is at fault. That *he* should be subjected to mental and physical tests before being allowed to drive a car is unthinkable—from his standpoint. That *he* needs education in safe driving is all poppycock. That *he* is discourteous, thoughtless, careless, and all the other things that contribute to accidents, is not even to be mentioned. But possibly *he* is wrong. *He is* wrong. So many of the accidents today point to human frailties that the education of drivers may be taken as a foregone conclusion. Such education must be taken up and carried forth forcefully by communities, states, and the federal government before any other safety factors will have much effect on our present unenviable accident record.

The motor-car manufacturer frequently is held responsible for accidents. "Cars can be driven too fast; limit them mechanically to 45 miles per hour maximum speed," say the unthinking. Little do they realize that the maximum speed of a motor car is a definite index of its development, its efficiency, and its perfection. Furthermore, the acceleration possible with modern high-speed cars is frequently a prerequisite of safety. On the other hand, accidents at 45 miles per hour can be just as horrible, just as disastrous as those at much higher speeds. Any attempt at limiting mechanically the maximum speed of cars can have little effect on reducing accidents, but conceivably can have a very definite effect on increasing them.

Motor-car manufacturers this year have concentrated more on improving the safety features of their cars than in any year past. Radical improvements in brakes have brought the cars under better and safer control of drivers; automatic operation of choke and throttle have made it possible for the driver to keep both hands on the wheel—where they belong—for a greater percentage of driving time; better lighting equipment is tending to make night driving safer; and safety glass all around is now the rule rather than the exception.

Highway construction has come in for mature consideration during the past year. Three, four, and five lane highways built only a few years ago have come to be termed "Death Highways," and rightly so. The realization has been reached that, in congested areas where traffic on super-highways is heavy, something more than a white line is needed to keep traffic separated as it moves in opposite directions. Parkways are the coming thing, and many are under construction at the time of writing.

We have here touched briefly the three major factors in motor car safety. To these, among others, should be added the need for uniform traffic laws, better policing of congested areas, elimination of busy grade crossings, and drastic enforcement of traffic regulations.

Above all stands the human element. Educate the driver, inculcate in him the principles of courtesy and consideration for others, be sure that he is mentally and physically fit to drive a car. Then watch our accident rate drop.

Transatlantic Monstrosities

TWICE, recently, one of our esteemed British contemporaries has quoted statements to the effect that Washington and American shipping interests have been concerning themselves with plans for construction of a super liner to surpass both *Normandie* and *Queen Mary*. Rather surprised at the first, we let it pass as a rumor of no consequence; on reading the second, we began to wonder whether some secret maneuvering were taking place. A query to the Department of Commerce elicited the response that "At the present date we are not informed of any intentions or activities in the type of new construction you mention."

Strange! Or can it be that the Department of Commerce has not been consulted, only the bureau which is to hand out the money being let in on the secret so far? There's chicanery somewhere without a doubt. "Where there's smoke . . ." Yet P. A. S. Franklin adds to the mystery by denying "a report that the United States Lines will build a ship of 100,000 tons." They will, he says, proceed with plans to build a third liner similar to the *Manhattan* and *Washington*, but slightly larger.

The record thus seems clean. But is it? We wonder. Somewhere somebody has discussed the matter, seriously or with intent vague. However that may be, it is well to say a word of warning against such transoceanic monstrosities lest, in a spasm of nationalism, the nation be propagandized into piling absurdity on absurdity.

As spectacular examples of man's handiwork, the *Normandie* and the *Queen Mary* are successes; as financial ventures they can never be anything but failures. The former has operated at a great loss (to the French Government), for American travelers, on whom all transatlantic liners depend for their existence, are turning more and more to American ships to keep their money at home. The "blue ribbon of the Atlantic" and the prestige—for which the *Normandie* was built—cannot offset her failure as a profit maker.

The American *Manhattan* and the *Washington*, on the other hand, cost far less per ton to build; are each only about a third the size of the *Normandie* but are still huge, comfortable, luxuriously appointed, and fast; and their operating cost is far less than one third that of the French ship. The deduction is simple: from four to five of the smaller size can be built and operated with the same capital required for one of the larger; more frequent schedules can be maintained and more passengers carried; and in a war emergency, a fleet of the smaller would serve us far more efficiently as naval auxiliaries than one monster. Let us, then, talk sense, even though it be only to start a rumor!

AIRCRAFT in warfare is a controversial subject that has been the cause of spoiling much white paper with printer's ink. All too frequently that spoilage has been for naught—to put forth the ill-considered mouthings of irate militarists or pacifists, as the case may be. Here, however, Mr. Cleveland has taken the long view, the sane view. Without wasting words, he has drawn a sharply delineated picture of the position in which American air transportation would find itself in the case of a national emergency.—*The Editor.*

CIVIL AVIATION

By REGINALD M. CLEVELAND

MUCH loose talk has been heard of late about the conversion of civil aircraft into instruments of war. In Europe there is some foundation for the theory that large transport airplanes would be useful as bombers because, until very recently, British and European passenger airplanes—with a few notable exceptions—have been adaptations, with comparatively little change, of craft primarily laid down to the specifications of air ministries for bombers.

In the United States, however, military aircraft of all types, and civil aircraft, large and small, have pursued a development along widely divergent roads. It is true, of course, that aerodynamic improvements, first applied to either military or civil airplanes, have soon found their place in the craft of the other category. There has been, in other words, an exchange of ideas, especially along engineering lines, which has been beneficial to both types of airplanes. To assume, however, that American transport planes could be converted successfully to bombers, or smaller fast mail ships to pursuit and attack craft, is to fall into serious error. The civil aircraft of this country, which, by reason of their remarkable speed and safety records, have aroused so much envy, are not stressed for military maneuvers with military loads. They are constructed and stressed for the specific function they perform so well, but cannot be considered in the light of combat equipment.

THERE are other aspects, however, from which civil aviation in the United States can indeed be considered a backbone of national defense. If the popular conception of huge airliners carrying a ton of bombs instead of a ton of passengers and of sleek mail ships spitting fire from hastily-mounted machine guns will not stand the acid test of fact, the less romantic, but much more important, conception of civil aviation as a pool of invaluable pilot reserve material, as a network of strategically placed airports, and as an incomparable means of rapid military transport, always ready for use, most emphatically will.

The most recent compilation of figures shows 14,177 persons holding pilot's licenses in the United States. This, of course, is exclusive of military pilots. Of the civil total, 7132 held the highest rating, transport license; 828 were limited commercial, 5395 private, 717 amateur, and five industrial—the last named a grade for which licenses are no longer issued.

On the same date there were, however, only 6972 aircraft holding license. Of these, a very large number would be entirely useless for purposes even contributory to defense. It is safe to say that at present not more than 2000 airplanes in the civil category could be of direct use in time of national emergency. It is evident, therefore, that there is a very considerable surplus of transport pilots. Some authorities who have given careful study to the question hold that many more transport pilots will be needed in time of emergency than the actual number required to fly the number of serviceable airplanes—serviceable, that is, in the sense of military auxiliaries. But it is evident that even allowing for a number of transport pilots double that of such useful planes, a large reserve of these highly-trained men would still be available.

They could and would be used, of course, to train other pilots and to speed the whole machinery of augmenting the actual useful force in the air. Many of them would make ideal material, possessing a head start of obvious value, for combat pilots.

The most recent figures on airports and landing fields in the United States, compiled by the Bureau of Air Commerce, show 2343 of all types. Of these, 693 are partly or fully lighted for night operation. Of the total, 717 are municipal and 539 are commercial airports; 277 are Department of Commerce intermediate landing fields; 619 are auxiliary fields; 59 are army airdromes; 26 are naval air stations; and 106 are miscellaneous government, state, and private airports and landing grounds.

The importance of this network of airports, linked in a nation-wide system of more than 20,000 miles of lighted and radio-equipped airways, could hardly be overestimated in a time of national emergency. It is generally conceded that any war of the future will be primarily a war of the air. This involves, however, not merely aerial combat, but the aerial movement of troops, of fuel for combat airplanes, ammunition and bomb reserves, replacement and repair parts, and a host of other items for which speed will also be a prime necessity.

Stressed for different services. A giant Boeing bomber*, and at right . . .

A Federal airway, in the present sense of the term, means much more than the shortest airline between two points. The facilities now provided on every Federal airway include rotating beacon lights at approximately 15-mile intervals; intermediate landing fields so located in relation to airports that landing

*The recent crash of this ship was apparently not due to defects in design, but to other factors beyond control.

ATIONAL DEFENSE

areas are available at intervals of about 50 miles; radio communication stations for weather broadcasts and emergency messages to aircraft; radio range beacons for directional guidance; radio marker beacons for assistance in locating strategic points, such as intermediate landing fields, and, in many cases, for giving directional guidance over short distances; and weather reporting service involving the use of teletypewriter circuits and point-to-point radio.

It is in the elaborately integrated system of civil aviation and especially of air transport, making use of these far-flung airways, that the greatest contribution to national defense is to be found. Air transport service has reached a speed three times that of the railroad. Large fleets of airliners can cross from coast to coast in 16 to 17 hours. Hundreds of transport planes could be mobilized for any emergency and flown from one end of the country to the other within 24 hours.

The experience in the World War proved conclusively that transport equipment cannot be developed quickly enough after a declaration of war, and that therefore equipment and facilities can be established more efficiently and at less cost by normal development in times of peace. All who have given serious thought to preparedness, including those who had the responsibility of creating new industries and other facilities during the World War, agree that Government support is especially warranted when modest subsidies in peace will pay for developments which will prove costly out of all reason in both time and money if postponed until forced by an emergency.

THE present development of large passenger planes, fast night mail ships, and auxiliary equipment, is due in large part to the gruelling work demanded in scheduled airline operations. Flying millions of miles, nearly half the time at night, in all kinds of weather, over every conceivable kind of country, month after month, year after year, contract mail lines have forced the present rapid rate of improvement and made it available for emergency use.

Both the Army and Navy have some transport airplanes, but they are entirely inadequate in number and carrying capacity to meet an emergency. Multi-engined transports, cruising at 175 to 200 miles an hour, of which the scheduled airlines have about 90 percent, would be used on the airlines themselves during any war emergency which might arise, to meet the inevitable demand for accelerated speed of transportation which is inherent in a war. At the same time, they would be required by the military forces for the swift transport of supplies, personnel, and munitions at the base of supply and in the zone of operations.

It is held that if war ever should be forced upon the United States, our combat air forces would require air-transport co-operation under four sets of circumstances: One; if the United States were attacked, the quickest possible type of transportation would be needed to concentrate aerial defense at the point of attack. Two; if an enemy secured a foothold on the American continent, surface transport into that zone would undoubtedly be useless, and air transport would be employed to the fullest extent. Three; if the war theater were across the water, the fastest possible transportation would be required between points in the interior of the United States and ports of embarkation. Four; in any theater of war, transportation at maximum speed—assured only by air—would be required between supply bases, concentration areas and the front lines.

In view of the accelerated speed of flight, both civil and military, conclusions of the American Aviation Mission which studied the lessons of the air in Europe in 1919, seem now to apply with even increased force.

"For economic reasons," it stated, "no nation can hope in time of peace to maintain air forces adequate to its defensive needs, except through the creation of a great reserve in personnel, material, and producing industry, through the encouragement of civil aeronautics. Commercial aviation and transportation development must be made to carry the financial load.

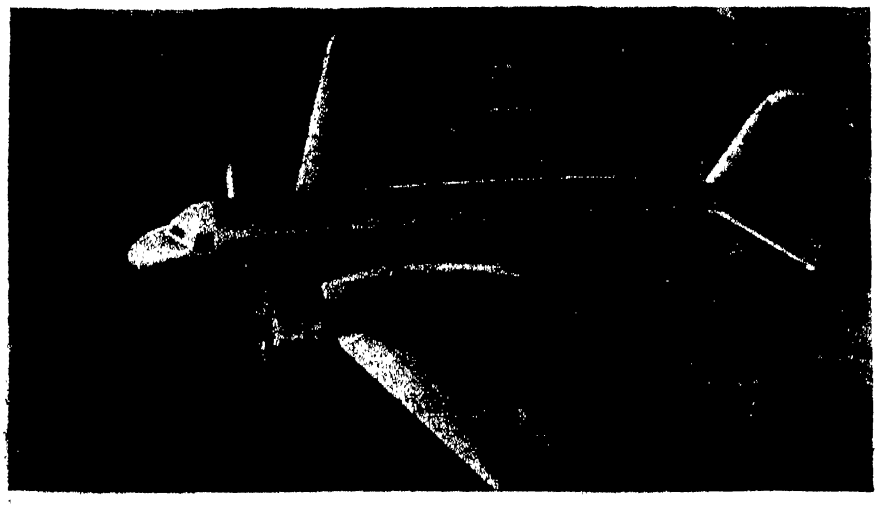
"Past experience and every economic consideration point to the vital need for the formulation by the United States of a definite, comprehensive and continuing policy for the development of every phase of the aircraft art. Our Government is now faced with the task of nursing and actively encouraging a new transportation industry whose healthy growth is vital to the future progress and defense of the nation."

MAINTENANCE bases of major air lines*, which would be of great value to our military forces in case of a national emergency:

Butte, Mont.—National Parks Airways.
Cheyenne, Wyo.—United Airlines.
Chicago, Ill.—United Airlines; American Airlines.
Cleveland, Ohio.—Pennsylvania Airlines & Transport.
Dallas, Texas—Braniff Airways.
Detroit, Mich.—Central Airlines.
Fort Worth, Texas—Bowen Airlines; American Airlines.
Kansas City, Mo.—Transcontinental and Western Air.
Los Angeles, Calif.—Western Air Express Corporation.
Miami, Fla.—Eastern Air Lines Division of North American Aviation.
New Orleans, La.—Wedell-Williams Air Service Corporation. (Overhaul base at Patterson, La.)
St. Louis, Mo.—Chicago and Southern Air Lines.

*Compiled by Bureau of Air Commerce, Department of Commerce.

. . . a TWA Douglas transport, mechanically flown by the Gyro Pilot



THE 'SPACE-PENETRATING

By HENRY NORRIS RUSSELL, Ph. D.

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Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington
President of the American Astronomical Society

VISITORS to an observatory on a "public night" very often ask: "How far can you see with this telescope?" The only direct answer is: "That depends on what you are looking at." With the unaided eye, a glow-worm may be lost to sight at perhaps a hundred yards, while the Andromeda nebula could be seen at a million light years.

With a small change, however, the question becomes reasonable. How faint an object can be observed with a given instrument?—or in more technical language: What is the limiting stellar magnitude which can be observed?

The importance of the question is obvious, but to answer it is not so simple as might appear, for the result differs greatly for various methods of observation.

The simplest case is that of ordinary visual observation of stars. A good objective, whether lens or mirror, combined with a good eyepiece, produces an image of a star, upon the retina of the eye, which falls practically upon any one of the sensitive nerve-endings. So all the light gets to the place where it is wanted, and the main question is how much light falls upon the aperture of the telescope. This is evidently proportional to the square of the diameter of the clear aperture. A ten-inch telescope should collect a hundred times as much light as a one-inch telescope, and show stars five magnitudes fainter. It is found by experiment that a one-inch objective, in good adjustment, will show stars to the 9th magnitude: so a 10-inch should go to the 14th magnitude, and a 100-inch to the 19th. The general formula is simple:

$$m = 9 + 5 \log d \qquad (1)$$

when m is the limiting magnitude, and d the common logarithm of the diameter of the objective.

IF we tried to get a formula accurate to tenths of a magnitude, we would have to consider the loss of light in passing through the glass of the lenses, or on reflection from (possibly tarnished) mirrors, but we need not bother with this.

Allowance would also have to be made for differences in eyes—though the general run of observers seems to be about equally good at seeing faint objects, with an occasional case of exceptional vision like Barnard's. Incidentally the assumption should be expressly stated that defects of refraction in the observer's eye are corrected by spectacles.

One provision, however, must be made: the magnifying power of the eyepiece must not be too low. It is well known that the ratio of the diameter of the objective to that of the beam of parallel rays which emerges from the eyepiece is equal to the magnifying power. Now the pupil of the eye is about one fifth of an inch in diameter (under the ordinary conditions of faint light in an observatory). If the "emergent pencil" is of larger diameter, only a part of it will enter the eye. To avoid this, the magnifying power must be at least five times the diameter of the objective in inches. A power of 500 is necessary to get the full benefit of the 100-inch mirror, and 1000 would be needed for the 200-inch.

A 10-inch telescope with housing that rolls off on a track, made by R. G. Stephens of Kennebunk, Me. "It is very easy," he writes, "to roll the house back over the telescope when through observing, and all is then secure." The observing is done entirely in the open air, as shown

All that has been said so far deals tacitly only with good seeing conditions. Every observer, amateur or professional, is only too familiar with the bad nights—perhaps very transparent to the naked eye—on which the images of the stars not only dance about, owing to the irregularities of atmospheric refraction, but frequently "burst" into diffuse patches, changing from one instant to the next. Under such conditions, the faintest stars are lost altogether and the effective limiting magnitude is changed for the worse; that is, its numerical value on the familiar scale is lowered.

But present-day professional observations are made mainly by photography. Here we have two different questions: First: What will our telescope show with a given exposure—say one minute—and second: What will it show if we go to the limit of practicable exposure?

The first problem is very like that of visual observation. Our supposed exposure is far too short to fog the plates. If the seeing is very good, the photographic images of faint stars will be as small as the inherent limitations of the photographic emulsion permit—about 1/800 of an inch in diameter. Once again all the light, barring instrumental losses, gets to the desired place, and a ten-fold increase in diameter should show stars five magnitudes fainter. We will have an equation of the same form as (1), but the numerical constant will evidently be different for different kinds of plates (extra-rapid or lantern slide) and also for different fixed exposures.

HERE, alas, we meet with one of the saddest facts in astronomical photography. To increase the exposure ten times, with the same intensity of light, does not produce the same effect as to keep the same exposure but make the light ten times stronger—it produces a smaller photographic blackening.

If the simple "reciprocity law" just stated held good, the limiting magnitude would increase by 2.5 log t (t being the exposure time) but the actual gain is about 2 log t—sometimes a little more. This peculiarity of photographs, discovered by the lamented Schwarzschild, is a serious matter for long exposures. To get stars five magnitudes—100 times—fainter we have to expose about 300 times as long. By the time the exposures reach into hours, however, astronomical photography meets with a new and unescapable obstacle—the fogging of the plate by the general light of the sky.

It has been known for 20 years or more that only about a third of the light which is received from the heavens on a perfectly clear dark night, in places out of reach of artificial light, comes directly from the stars. About an equal amount originates in the earth's atmosphere. Just as the sun's light is scattered by day, to give the blue sky, so

TELESCOPES

Compare Two Telescopes With Same Aperture but Different Focal Lengths . . . Limitations of a Great Telescope . . . Seldom at its Best

star light must be by night: but the greater part of the observed luminosity shows a spectrum of bright lines or bands, and seems to be something like a permanent faint aurora (though probably not of exactly the same physical origin). Finally, a considerable portion of the light of the night sky comes from the extension of the zodiacal light over the whole heavens, and is presumably due to sunlight reflected by myriads of tiny particles scattered through the whole inner part of the solar system.

If we could get above the limits of our atmosphere, we would lose fully half the general sky-brightness—less near the sun where the zodiacal light is bright, and more near the poles. But to get a really clear sky, between the stars, an explorer would have to go far toward the confines of our system. If he could settle down on one of the satellites of Uranus (which are probably too small to have any atmosphere) he would see the heavens appear very differently. Apart from the bright haze around the sun, the sky would be black, and the Milky Way would be vastly more prominent than to us—including the dark regions of obscuration—while the Andromeda nebula would be conspicuous.

BUT we earth-bound astronomers must struggle with the light of the sky as we find it. There is no use increasing our exposures after plates become definitely fogged by this cause, and we have no longer to deal on our negatives with star images on a clear ground, but with darker spots in the incipient fog. Experience shows that if such an image on our plate is of considerable size (say a millimeter in diameter) it will be perceptible if the intensity of the image-forming light is but a few percent of the uniform sky foreground. But our star images are very small, and under these conditions it is found that to get anything definite, the light falling within this image from the star must be about equal to that from the diffuse illumination of the sky.

This changes things enormously. At the ideal limit, when the star-images were as small as the plate-grain permitted, there would under some circumstances be no gain at all in using a large telescope. This sounds absurd; but it is simple enough. By hypothesis, we have exposed long enough to begin to fog the plate, so that longer exposure would be no gain. For a telescope of given focal length the star image, 1/800 of an inch in diameter, corresponds to a definite region of the sky, of a given diameter in seconds of arc. From this bit of sky, we will get a definite amount of light, simply from the general illumination. The star which sends us

A 10-inch telescope with tube of waterproofed cardboard, made by Chas. W. Sloper, Pittsfield, Mass. Casein glue was the waterproofing agent and the telescope stood out in the rain and the sun for a long time without damage—though the seams were very carefully blocked

more than this amount will show a visible image: one which sends us less will be lost in the background. With the large aperture, the exposure would of course be much shorter, but the final picture would be the same.

There would, however, be a great advantage under these conditions in using a *long* telescope. By increasing the focal length—while the star-images are still of the minimum possible size—the area of the sky whose light faces on the region of the images is decreased, and stars previously unobservable may be reached. We may now compare two telescopes of the same aperture, but different focal lengths. The light received from the star is the same in the two cases, but, with the longer focus, the sky-light on the plate is much fainter (inversely proportional to the focal length) and so we may make a longer exposure before we fog the plate. Theoretically, in this idealized case, the limiting magnitude should be given by

$$m = \text{constant} + 5 \log f \qquad (2)$$

(f being the focal length). For the same focal length, the large aperture would have a great advantage in speed.

Telescopes of the same kind are usually designed with more or less the same value of the focal ratio d/f. For refractors, this is usually about 15—for reflectors it may be made as small as five or even less. Among telescopes of the same type and focal ratio, the large aperture regains its full advantage, for d is proportionate to f, and equations (1) and (2) give the same relative performance.

These considerations are valid, approximately, only under very rare conditions of good seeing. On ordinary nights, the star images in the field of view of a large telescope dance about by much more than 1/800 of an inch, so that the photographic image of the star is a more or less fuzzy "tremor-disk" whose diameter depends on the weather (astronomically speaking). Under extreme conditions, we may assume that the average distance to which the image deviates from its mean position is a definite number of seconds of arc. Within a few seconds of time, the star dances all over the region, so we may assume that the tremor-disk has a fixed angular size whatever the exposure. On this assumption, the amount of general sky illumination which gets mixed up with the star's light is a fixed quantity, depending on processes which occur in the earth's atmosphere, and not in the telescope. The limiting brightness of a star observable in this particular grade of bad seeing will thus depend only on the effective diameter S of the tremor-disk: and the equation may easily be derived

$$m = \text{constant} - 5 \log S \qquad (3)$$

Under these ideally bad conditions one telescope is as good as another—providing always that the exposures are made to the fog-limit—but the worse the seeing, the more stars we lose.

THE full advantage of a great telescope can therefore be realized only under the best conditions of seeing. Everyone knows that this is true for the study of fine details, such as double stars or planetary markings; but it is less well recognized that it is true also when it comes to the detection of very faint, and doubtless very distant, stars.

The writer is much indebted to a discussion of this topic (at a colloquium meeting yesterday) by Dr. J. A. Anderson, who has kindly permitted this non-technical account to be given here. —*Mount Wilson Observatory, Nov. 2.*

The entrance to the cave at Choukoutien where the skull of Peking Man was found. Natural passages in the limestone formation lead to the floor of the cave, 60 feet below the entrance. Rocks fallen from the walls long ago buried the skull deeply

THE FOOD OF PEKING MAN

By DR. RALPH W. CHANEY
Research Associate, Carnegie Institution of Washington
Chairman, Department of Paleontology, University of California

THE feeding habits of the earliest man-like animals have been known only through conjecture. Our human ancestors of a million years ago had not mastered the art of writing, and so did not leave grocery lists or books of recipes as evidence of their dietary preferences.

From analogy with the feeding habits of the large modern apes, they may be supposed to have eaten both plant and animal food. Such an omnivorous diet is also suggested by the character of the fossil teeth of early man, which seem to be suited for chewing a wide variety of foods, both flesh and vegetable.

The actual record of early man has until recently included no direct evidence as to his food. *Pithecanthropus erectus*, the Java man discovered in Java in 1891, is represented only by a portion of the skull and a few skeletal fragments. The Dawn Man, *Eoanthropus* from Piltdown, England, is also represented by incomplete material, with no suggestion as to food and feeding habits other than that afforded by his teeth.

It was only with the discovery of a third race of primitive man, dating, as in the case of *Pithecanthropus* and *Eoanthropus*, back to the beginning of the Pleistocene, or Ice Age, that actual living quarters of our early ancestors were discovered.

Members of the National Geological Survey of China, under the supervision of the late Dr. Davidson Black, uncovered several skulls and numerous teeth of the oldest human inhabitants of Asia during the past six years. In addition, stone implements, hearths and uneaten fragments of food have been found in the home of these ancient cave dwellers. Here is the first record of the diet of the most ancient human individuals known from the continent of Asia.

LIMESTONES deposited in a shallow sea hundreds of millions of years ago are exposed in the Western Hills near Peking, the former capital of China. Due to the dissolving power of underground water, caves have been formed in the rocks of these hills which at various times have offered shelter to the early human inhabitants of China, and to hyenas and other animals which make their dens underground. Portions of the caves in the Western Hills became partly filled with fragments of rock which fell from walls and ceilings, and which became cemented, through the deposition of calcareous material by percolating waters, into a solid mass known as breccia.

So it came about that in our day, Chinese workmen, quarrying limestone for building material and for use in road construction, came upon these irregular masses of breccia which they left untouched because of their impurity. In 1923, the famous Swedish paleontologist, J. G. Andersson, studied these breccias, and discovered in them fossil bones of rhinoceros, bison, and other animals no longer living in northern China. The painstaking excavation of these bone-bearing masses of breccia has resulted in the unfolding of an early chapter of human history on the continent of Asia.

The town of Choukoutien (pro-

Man's First Dietetic Record Found in His Actual Living Quarters . . . Oldest Known Inhabitant of Asia . . . Fossil Garbage . . . A Rare Specimen

nounced Cho-ko-tyen), lying 30 miles west of Peking, is a local center for the mining of coal and the quarrying of limestone. Some years ago, a railroad was built to transport these heavy products to Peking, but recent political unrest in North China has caused the diversion of its rolling stock to the activities of war. As a result, long lines of camels—the two-humped bactrians of interior Asia—plod along the dusty roadways, now and then delaying the progress of our donkeys as they climb the long slopes to the quarries.

On the hill above Choukoutien, and beside the cave containing the most productive bone deposits, the National Geological Survey of China has built a commodious laboratory with living quarters for the staff of scientific workers engaged in this detailed excavation. Here have come visitors from all parts of the world, including many famous anthropologists and paleontologists, attracted by this most complete record of early man. Scattered over the hillside are fragments of breccia removed from the cave whose entrance offers shelter from the warm sunshine.

IT SEEMS certain that one or more entrances were used as doorways by man and other animals in the past. These have fallen in or been covered up, and their possible discovery during future excavations may disclose important facts now concealed. Down through limestone passages to a depth of 60 feet below the present entrance, the floor of the cave is reached—the actual living quarters of the oldest known inhabitant of Asia. Here, covered over by many feet of breccia, have been found the skulls which indicate that this early man had mental attainments sufficient to raise him well above the level of other animals.

From his discovery near the city of Peking, he is called "Peking Man"; his scientific name is *Sinanthropus pekingensis*[1]. Proof of his technical skill is found in the crudely fashioned flakes of quartz—the tools with which he cut and scraped. His use of fire is shown by the several feet of ashes, piled deeper against the walls of the cave where a not too fastidious Peking Woman may have swept them rather than carry them outside the cave.

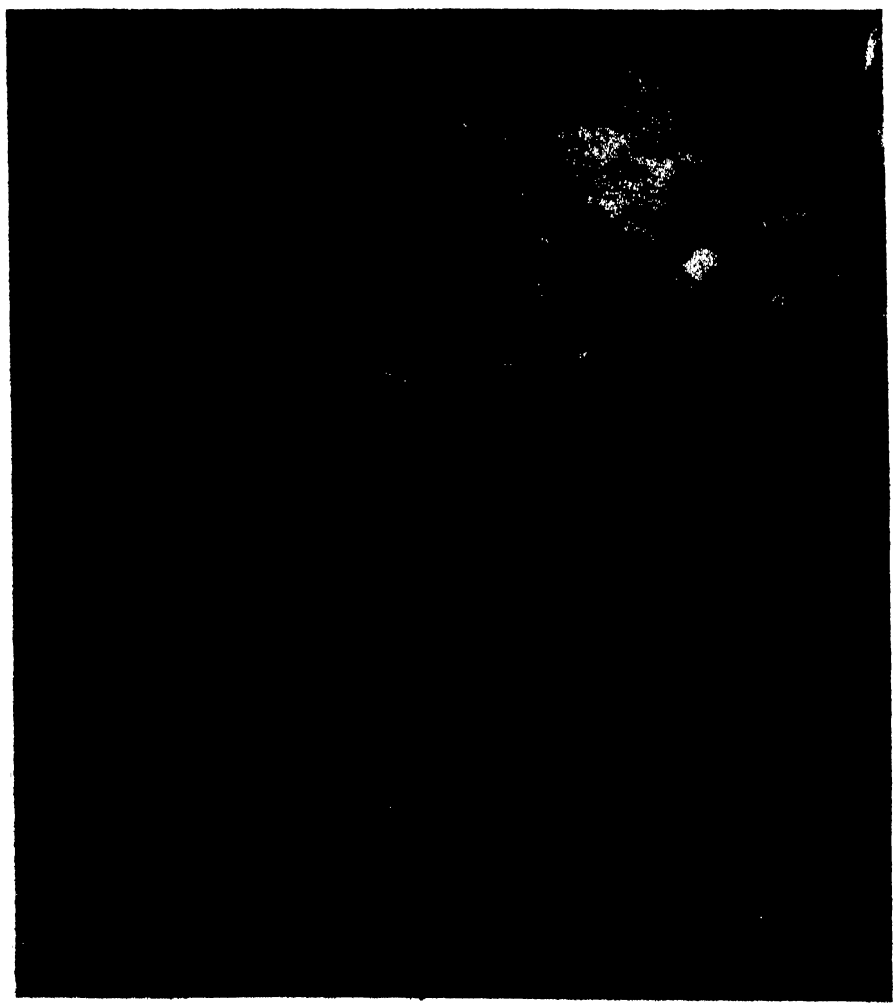
Several significant discoveries have been made in these ash layers. Bits of incompletely burned wood have been identified as similar to plants now living in northern China and in other lands with a somewhat cool and dry climate. Abundant fragments of charred bones indicate that here were cooked choice cuts of horses, bison, rhinoceroses, and other game animals which ranged the Western Hills and adjacent plains during the past, and which have no living relatives in North China today.

These animals, used as food by Peking Man, indicate a plains country, probably with trees confined to the stream borders as in semi-arid regions today. The fact that this man lived in caves, and that he made fires to keep himself warm or to cook his food, may be interpreted as indicating that the climate was characterized by low temperatures. During this same epoch of geologic time, large portions of North America and Europe were covered by thick sheets of ice, and so this time-period of the earth's history is commonly called the Ice Age. Glaciers appear to have been absent in northeastern Asia, due to its relatively dry climate.

About 20 feet above this lowest level of human occupation, and occurring in breccia containing numerous quartz artifacts and bone fragments, there is a layer several inches thick, made up of thousands of fragments of the shells of seeds. The markings on their surface indicate that they represent the shells of hackberry seeds—small globular bodies, smaller than peas. How they got into the cave and were broken into bits is a problem of major importance.

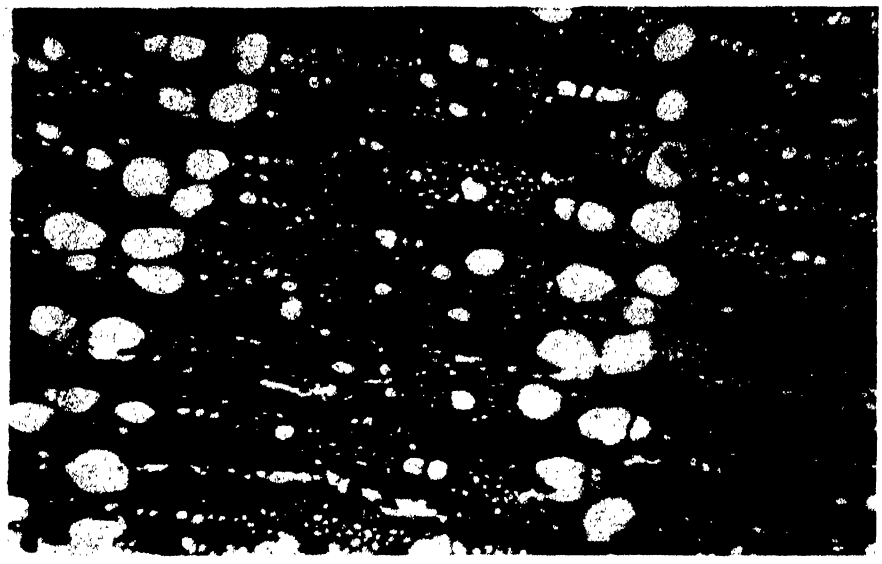
THE modern hackberry (*Celtis*) occurs as a small tree in the forests both of North America and Asia, but is most characteristic as a shrub on semi-arid slopes and stream borders. Neither wind nor running water—two of the more common agents of transportation—may be supposed to have carried these seeds into the cave. Equally impossible is the assumption that hackberry bushes lived in the cave, for direct sunlight is essential to the growth of all higher plants.

It seems certain that large numbers



This cave contains deposits of ashes many feet thick, also charred bones, indicating clearly that it was long occupied by people who knew the use of fire

[1]Scientific American, June, Sept., Nov., 1930, contained articles on Peking Man.—*Ed.*



Fragments of the charred wood of the redbud found in the ash deposits in the cave. Note the traces of annual rings, indicating a climate like that of today

of hackberry seeds were carried into the cave, and their shells crushed while they were being eaten. The question arises as to whether early man or some other animal was responsible for bringing them into the cave at Choukoutien.

The fruits of the hackberry are like small cherries, skin and pith enclosing a shell, within which lies the seed. In the more arid parts of the United States, these fruits are extensively used as food by birds and rodents, and by the native Indians. Certain trees and shrubs bearing especially large or sweet fruits are regularly visited by the Indians of the Southwest.

THE fruits are in some cases eaten like those of the cherry—the skin and pith swallowed, and the shell rejected whole. Or they may be chewed so that the shell is broken into fragments, the larger of which are ejected from the mouth.

The most common use, however, is as a flavoring for meat or bread. The fruits are crushed fine, and the liquid strained away and cooked with other food, leaving a residue of shell fragments which are cast aside. If Peking Man utilized hackberry fruits in this fashion, we should expect to find in his cave-home accumulations of broken shells like those actually occurring.

The presence of the fossil bones of rodents in the cave at Choukoutien suggests the possibility that they, rather than Peking Man, may have carried in the fruits of hackberry whose shells have been preserved in the cave deposits. With this possibility in mind, an effort has been made to determine how related living rodents open hackberry shells to secure the edible seed within.

All authorities consulted have indicated their belief that these animals would chew a small opening on one side of the shell rather than break it into fragments, in much the same fashion as a squirrel opens a hickory nut. Dried hackberry fruits were fed to several types of caged rodents in the laboratories at the University of California, but either these animals were not hungry, or they were unfamiliar with this type of food, for in no case did they chew through the shells of the berries given them.

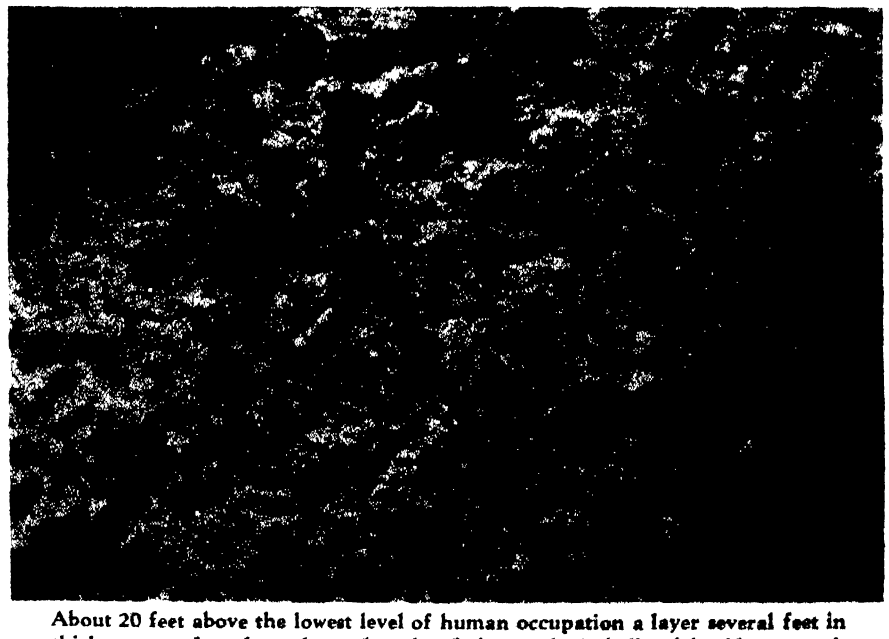
The behaviour of caged monkeys was more significant. They readily accepted the dried fruits and crunched and swallowed them, shell-fragments and all. No monkeys are known to have lived in northern China during the Ice Age. The fragmentation of the shells in the cave deposits is interpreted as indicating the probability that they represent the food refuse—fossil garbage it might be called—of the human inhabitants of the cave, rather than of its rodent population.

Here then is the earliest record of the use of plant food by prehistoric man. In a land so cool and dry that there were few fruits and nuts, Peking Man may be supposed to have gathered the hackberries from bushes near his home, and to have mashed them in the preparation of his meals as do the modern natives of our Southwest. The abundance of shell fragments in the cave deposits may best be explained in this manner.

THE brain cavity in the skull of *Sinanthropus* definitely indicates that this early human race was capable of speech. We can almost hear Peking Woman adjuring Peking Child, in a language lost in the obscurity of a million years, to eat his hackberry pudding in lieu of orange juice, or other vitamin-containing foods of the modern diet.

As I was about to leave this hill in northern China, in whose caves ancient man made his home nearly 1,000,000 years ago, my Chinese associates courteously offered me the opportunity of selecting a small piece of the cave breccia to take with me. I picked up from the pile of material excavated from the cave a block which weighed about two pounds, on which were exposed fragments of charred bones and a large quartz flake. An irregularity at one end required trimming, and with my hammer I broke it off. To my surprise there appeared on the broken surface of this piece of breccia an almost complete hackberry seed.

Here in one block have been preserved not only the remains of a prehistoric meal, both meat and vegetable, but the crude stone implement with which Peking Man may have killed his bison, cut his meat, or mashed his hackberries. These cave deposits tell the story of the feeding habits of man before he himself recorded the details of his life in writing.



About 20 feet above the lowest level of human occupation a layer several feet in thickness was found, made up largely of the crushed shells of hackberry seeds

SURER ARTIFICIAL RESPIRATION

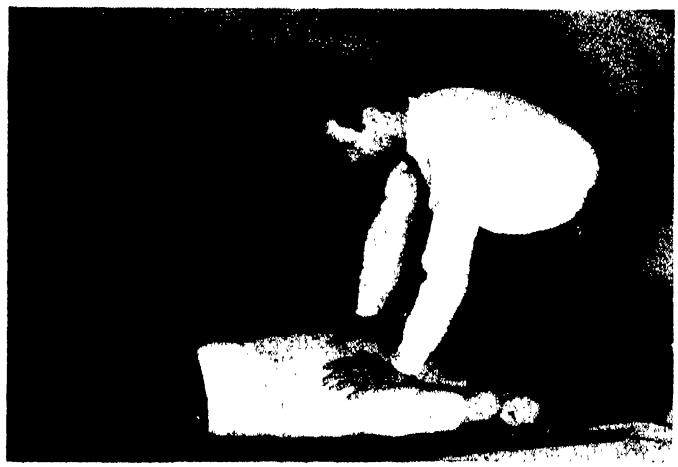
Nielsen Life-Saving Technique Surpasses, by 41 Percent, the Widely Used Schaeffer System

By F. D. McHUGH

FOR the first time in many years the Schaeffer prone pressure method of artificial respiration for insensible persons who have been, to all appearances, drowned, asphyxiated, or electrically shocked, has been improved upon. A new system of inducing respiration and resuscitating persons who have apparently died has a 41 percent higher efficiency than the Schaeffer method by actual test, in that it gives deeper breaths for a proper cleansing of the lungs, and more breaths per minute. It was developed by Holger Nielsen, a Danish sports inspector, as a result of years of study. So well recommended does the new system come that there is every assurance that the new system will replace the older, long-accepted, Schaeffer technique.

In the early part of the century, Sir Edward Schaeffer invented the system which has since borne his name and which has been the means of saving the lives of hundreds, if not thousands, of people. In this system the person to be resuscitated is placed face downward while the operator kneels over him facing the patient's head, his knees beside the hips of the patient. The operator places his hands firmly on the lower ribs of the patient, one hand on each side. He then leans forward, throwing the full weight of his body on his hands to compress the patient's lungs and thus expel air (and water in the case of a drowned subject). A quick release of the pressure after four seconds permits the patient's lungs to expand with a sharp intake of breath. This process is continued, at three-second intervals, until the patient revives or it can be definitely shown that there is no hope.

INSPECTOR Nielsen began the study of the Schaeffer system and also of the Silvester, another commonly used system, some years ago. He discovered that by both of these the respiration induced was not sufficiently deep to cleanse the lungs thoroughly. He realized that, for best results, the air should be forced deeply into the lungs. The Holger Nielsen technique which came as a result of these studies is more or less similar to the Schaeffer except that the operator kneels astride the patient's head and exerts the pressure of his hands on the patient's shoulder blades. The patient is placed face downward as in the older method and the operator kneels as shown in the accompanying illustration. His hands are so placed that on the release of the pressure he can slide his hands off the shoulder blades to grasp the patient's arms and lift them slightly. Lifting of the arms removes the patient's weight from his chest so that the lungs are permitted to expand much more than in other systems. The result is that about twice as much air is drawn in, according to authorities who have tested the system; noxious gases or water are evacuated, and natural breathing is started much earlier.



Resuscitator kneels astride the patient's head, presses downward on shoulder blades, and lifts arms on upward movement

In applying this Nielsen method to a patient, first remove his clothing or any parts of it, at least, which will tend to hamper the free movement of the patient's shoulders and lungs. Lay him face downward on a flat, hard surface. Should this surface be sloping, be sure that the patient's head is at the lowest point. Arrange his arms as shown in the illustration, bent and folded under his forehead, not so much to protect his face from bruising but to prevent any twist of the neck which would interfere with breathing. A handkerchief should be placed beneath the patient's mouth and nose to prevent the intake of dust. When patient and operator are in position, the patient's back must be slapped sharply between the shoulder blades several times to cause the tongue to fall forward out of the mouth. If this is unsuccessful, the operator draws it forward with his fingers.

Artificial respiration is then administered by the operator swinging his body forward, throwing only his weight, but no muscular force, onto the patient's shoulders. The movement is slow so that the pressure is progressive. The pressure is continued until the operator's arms are in a vertical position which he holds while he counts up to four. The operator then swings backward to release the weight and as he does so grasps the middle of the patient's upper arms, pulling them backwards just enough to lift them slightly without disturbing the position of the patient's head or torso. This position is held while the count is continued up to eight. The operator then assumes his original position and repeats the routine, the entire procedure being completed from seven to eight times a minute. There should be no break in the rhythm of this action until strong normal breathing is induced or for at least four hours in the event that no natural breathing may be detected.

Professor August Krogh, Nobel Prize winner of the Rockefeller Institute in Copenhagen, was the first authority to investigate this new system. After exhaustive tests on insensible persons, he gave it his unqualified endorsement. The faculty of medicine at the University of Copenhagen, the Danish Red Cross, the Danish Life Saving Association, the State Board of Public Health, and other interested bodies also have investigated and approved it. The Danish Red Cross has, in fact, adopted it and advised its use on all bathing beaches and in many industries. In countless instances the Nielsen method should be of great value in an emergency in the absence of, or before the arrival of, mechanical resuscitators.

We are indebted to Professor August Krogh for these facts.

DIESELS FOR BATTLESHIPS?

Large Number of Small Engines . . . Greater Fuel Economy . . . Quick Replacement, Repair . . . Simple Overhaul . . . Spares for Replacement

By CAPT. A. M. PROCTER, U. S. Navy (Ret.)

TWENTY-THREE years ago, the first ocean-going ship propelled by Diesel engines was put in service by the Eastern Asiatic Company of Denmark. This ship, after a long and profitable career, is still carried in "Lloyd's Register of Shipping" with the highest rating. The success of the *Seelandia*, and of other motor-ships which followed, led to the complete motorization of the Eastern Asiatic fleet; and, after the war, this new form of power attracted the attention of ship owners in other European countries.

In a few years the threat of the Diesel engine became so serious that, in the words of Sir John Biles, "Something had to be done to improve the thermal efficiency of the steam turbine."[1] This efficiency was materially improved by increasing the temperature and the pressure of the steam, but the fuel consumption of the steam turbine plant, in service, is still about double that of the Diesel engine, and the threat has not been met.

The steamer has continued to lose ground, and the latest returns given in "Lloyd's Register of Shipping, Quarterly Report" show that the motor horsepower of Diesel engines building, in the world at large, on September 30, 1935, exceeded that of steam plants by about 60 percent. If the horsepower of the *Queen Mary* (which is still carried in the total of the steam machinery under construction) is excluded, the Diesel horsepower is nearly three times that of the steam horsepower.

In spite of these well known facts there has been little enthusiasm outside of Germany for this form of power on the part of the designers of naval surface craft. This is somewhat difficult to understand because, on previous occasions, the naval designer has led the way in adopting improvements in marine engineering.

The use of internal combustion engines in submarines was forced from the beginning because, in spite of numerous attempts, it has not been possible to design a steam plant which would stand up under the rigorous conditions existing in this type. It is possible that the memory of troubles with early submarine engines has produced a fixation in the naval mind, which has not been removed by the evidence of the fact that commercial ship owners have found the Diesel engine to be fully as reliable as the steam engine.

[1] "Brassey's Naval and Shipping Annual, 1927."

The fact that it is possible to develop the power required by a modern battleship has been demonstrated by the German ship *Deutschland*. This ship and four others which have been laid down are fitted with a new type of high-speed engine developed by the Augsburg branch of the Maschinenfabrik Augsburg-Nurnburg, working in collaboration with the German Admiralty.

It must be admitted, however, that there has been, as yet, insufficient experience with this type to determine its endurance life, or its reliability in service. This will be a matter of several years; but, in the meanwhile, there is a type of engine available which has gone through a long period of development, and which is now available for the maximum power required.

THE use of this type—the four-stroke trunk piston engine—necessitates the use of a much larger number of units than that to which the marine engineer has become accustomed by experience. The presentation of the evidence justifying its use makes necessary a discussion of the details of the most mysterious of all professions—that of the ship designer. I will quote, therefore, Mr. Harry Ricardo, F.R.S., who, in delivering the sixth Thomas Lowe Gray lecture before the Institution of Mechanical Engineers, stated: "If, therefore, some of my statements and proposals appear outrageous, I must claim from you that tolerance which is the prerogative of either youth or inexperience. A cat may look at a King—presumably with an expression no courtier would dare to assume.

"I am going to look at the marine engineer with the cynical stare of the cat, secure in the knowledge that he will not harm a mere landsman. There are times, I think, when the outsider, ignorant of the traditions and quite undeterred by that vast accumulation of superstition which ties the hand of the expert, may happen on a new theme, or at least start a new train of thought."

Ricardo proposed the use of 75 motor-bus engines, with a direct current electric drive, for the propulsive plant of a 6000 shaft-horsepower cargo ship; and gave excellent reasons in support of this plan. I am suggesting a similar plan for a battleship drive, but with a smaller number of larger engines. This plan has, in addition to the well-known and often stated advantages of any Diesel installation, certain special advantages which may be enumerated as follows:

(a) A much greater freedom is given to the ship designer in the treatment of the problems with which he is primarily concerned.

(b) Since the removal of an engine, and its replacement by a spare, would be a matter of hours, all major repairs could be transferred from the ship—where they can not be properly made—to a shop where the engine could be rebuilt by methods developed in modern automotive practice.

(c) With 25 percent of spares—as is now the practice with turret guns—an annual replacement program would provide for the complete renewal of the plant, with new or rebuilt engines, once every four years.

(d) When better engines are developed—as will surely be done during the life of any ship laid down at this time—the whole plant could be renewed, one group at a time, without interfering with the operating schedule.

(e) Since not more than 25 percent of the engines would be used at ordinary cruising speeds, all routine examinations and minor repairs could be made at sea as well as in port, and a materially higher percentage of availability would be possible.

(f) The danger of a material reduction in power by breakdowns would be reduced.

(g) Since the working speed range of the engines would be not more than 40 percent of the total range, there would be no difficulty whatever in keeping clear of dangerous periods of torsional vibration.

(h) Since the engines can be installed under a deck which is far below

the water line, and between bulkheads far removed from the ship's side, they would be practically immune to attack by guns, bombs, and torpedoes.

The design of a battleship must, obviously, be a compromise between a number of conflicting interests; and it is inevitable that each group involved in its design and operation should approach the problem from a different angle. My own approach is that of an officer who, owing to the accidents of the service, has spent more than a fair share of his time in the operation and repair of worn out machinery. It is natural, therefore, that the most important advantage seems to me to be that listed under (b) above.

It is probable, however, that a judgment unbiased by personal experiences would be that the most important advantage lies in the freedom given to the ship designer in treating the ship as a whole as a fighting unit. Owing to the small size of the engines, they can be put in spaces which would not be available for larger units; and, after the military characteristics of the ship have been determined, places can always be found for the engines where they will be comfortable, contented, and well protected.

The number of arrangements possible is very large, and ranges all the way from a maximum of concentration, with the engines in three tiers behind the main armor belt, to a maximum of dispersion, with the engines in one tier extending beyond the main belt.

It is obvious that, with a large number of small units, electric drive must be used. This requires an addition of weight, and the fuel consumption at full power will be greater than that possible with the direct or geared drive. There are, however, certain fundamental facts which make it possible to keep the weight within the limit available and to keep the fuel consumption, at cruising speeds, down to that possible with a much smaller number of large units.

THE extra weight of the electrical equipment is balanced by the fact that, in engines which are geometrically similar, and which run at the same piston speed with the same mean effective pressure, the weight per unit of power varies directly as the ratio of the linear dimensions.

There are, moreover, certain modifying factors which turn the scale still farther in favor of the small engine. These are:

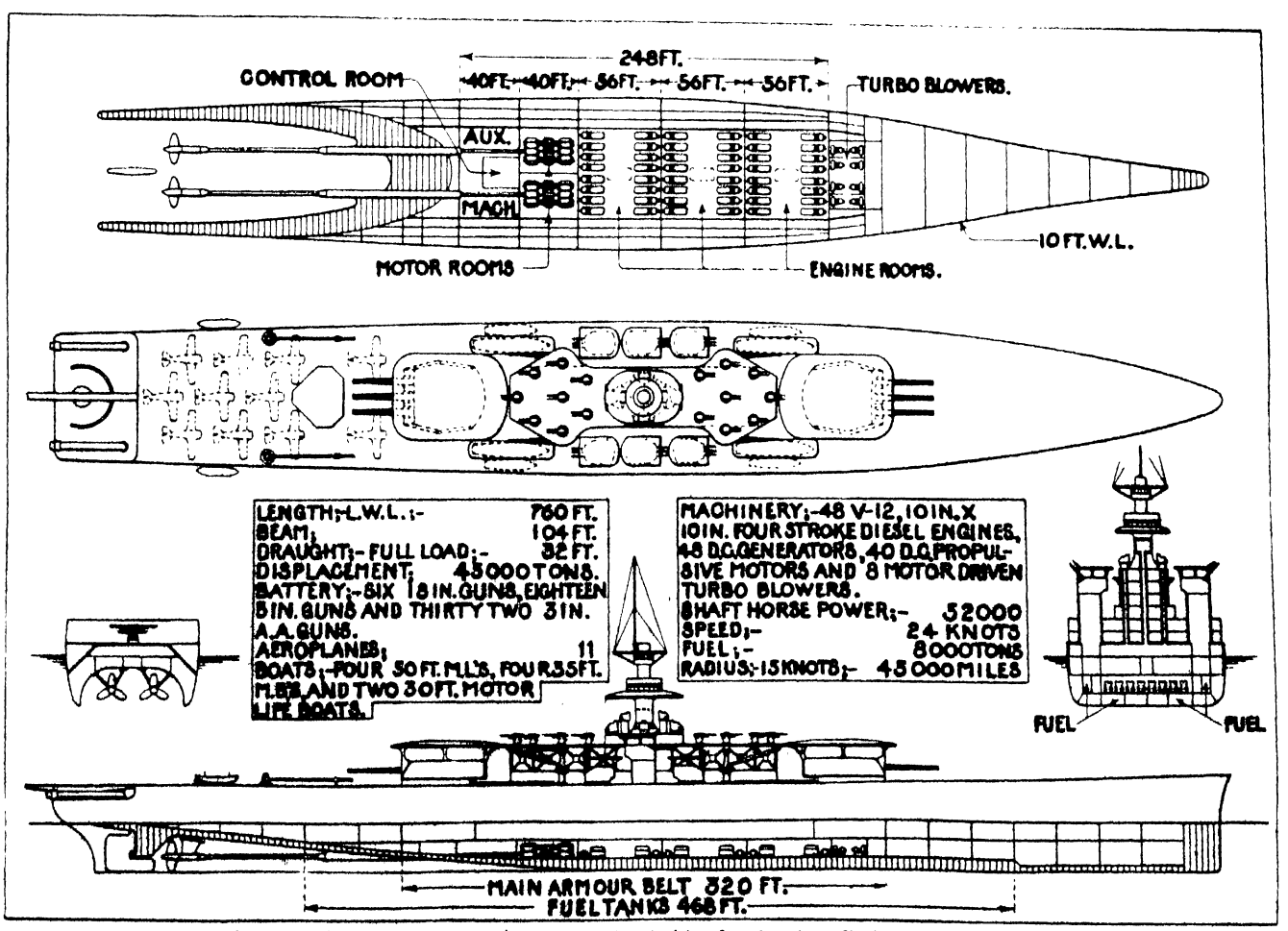
(a) As the size of the engine is increased, a point will be reached where it is no longer possible to preserve geometrical similarity, and it becomes necessary to use a type with a materially greater weight per unit of cylinder volume.

(b) The heat stresses, which are one of the most troublesome factors in the internal combustion engine, increase with an increase in the cylinder diameter, and limit the mean effective pressure at a lower value than that possible in a small cylinder.

(c) The unit bearing pressures which can be safely carried, decrease as the size of the bearings increase; and since, at high speeds, these pressures are due almost entirely to inertia forces, there will be a progressive decrease in the piston speed as engine size increases.

The electrical transmission loss will increase the specific fuel consumption at full power, above that possible with the direct or geared drive; but, in naval vessels, this is not important. At cruising speeds it will be possible, with a multiplicity of engines, generators, and motors, to select a number of units which will insure that they run at the point of maximum economy. This will more than balance the electrical transmission loss, when compared with large engines running at less than 25 percent of their rated power, and the economy of the proposed installation should be better than that possible with the alternative installations.

One of the many solutions possible is shown in the drawing. The proposed



Plan and elevation sections of proposed battleship showing installation of many Diesels

ship shown has a length about midway between those of type b and type c given in an article on "The Washington Conference and Naval Design," by Sir George Thurston, in "Brassey's Naval and Shipping Annual, 1923." This ship has a "standard" displacement of 35,000 tons; and, though somewhat longer, has about the same general characteristics as those of the *Nelson* and *Rodney*, which are the only ships which have been built in accordance with the Washington Treaty.

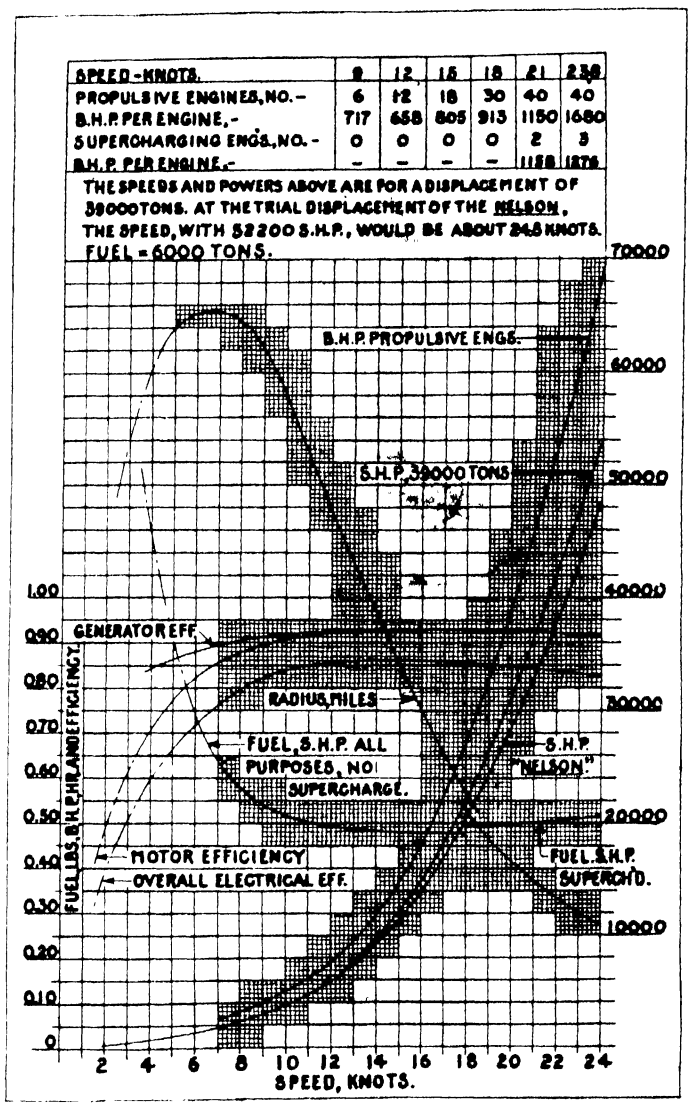
Since the limitations of this treaty are no longer binding, six 18-inch guns have been substituted for nine 16-inch guns. The weights of the guns and their mountings will be practically the same as those of the *Nelson* and the *Rodney*, but the weight of the turret and barbette armor will be materially reduced by substituting two turrets for three.

The main armor belt—which covers but 42 percent of the water line—has been reduced to about 80 percent of that of the *Nelson*, with a saving of about 1000 tons, which is available for some of the many demands made on the designer for weight in excess of that at his disposal. Up to the quite recent past it was held that the function of the armor belt was to protect the flotation of the ship, and all of the United States battleships from the *Maine* class, up to and including the *New York* and *Texas*, had complete water-line belts. The weight limitations were such that, in some of the early ships, the depth was so small that the top of the belt was under water when the ships were loaded.

Insistence on deeper and thicker armor made such demands on the weight schedule that it was not possible to provide a complete water-line belt, and it became necessary to provide other means of preserving flotation. The problem seems to have been solved, as was shown by the Germans at the battle of Jutland, by adequate subdivision, by water-tight compartments, and by preserving trim by counter-flooding.

In the *Nelson* and *Rodney* the weight of the armor has been concentrated to protect the ship against disablement by shells penetrating the machinery spaces, and against destruction by shells penetrating the turrets and magazines.

In the sketch shown, the attempt has been made to suggest the probable effect on design of a recognition of the increasing importance of aircraft, by fitting a larger and more adequate anti-aircraft battery, by providing a greater airplane equipment, and by fitting bursting hoods over the turrets. These details, however, have no bearing on the main purpose of this study which is to show the possibility of realizing the enormous advantages of the Diesel drive.



Graph of Diesel operation discussed by author

The machinery equipment proposed has 48 V-type, 12-cylinder four-stroke, supercharged engines driving direct current generators. The propellers are driven by 40 geared direct current motors; and, since the motor-driven supercharger blowers can be driven by three of the engines, five engines are available for the ship's auxiliaries and for reserve. The engines are all of the same size and power, and each of them can be used for propulsion, supercharging, or for carrying the ship's auxiliary load.

The engines, generators, and motors are removable through a hatch in the deck above (covered by a bolted plate) into a fore and aft passage which leads to armored trunks at the forward and after ends. Since all supercharging and ventilating air is taken through these trunks, there is no necessity for water-tight doors or hatches of any kind through the armored deck. The engine exhaust pipes are carried in fore and aft passages outside of the engine compartments and discharge over the stern.

Performance data of the proposed installation are shown in the graph. These data are based on a minimum fuel consumption of 0.40 pounds per brake horsepower per hour, which is conservative when compared with results which have been obtained in a number of recent engines.

The cruising radius curve is based on a fuel capacity of 6000 tons, but since the capacity of the ship shown in the drawing (with wing tanks and double bottom tanks eight feet deep) will be at least 8000 tons, the actual distances will be about 33 percent greater than shown by this curve.

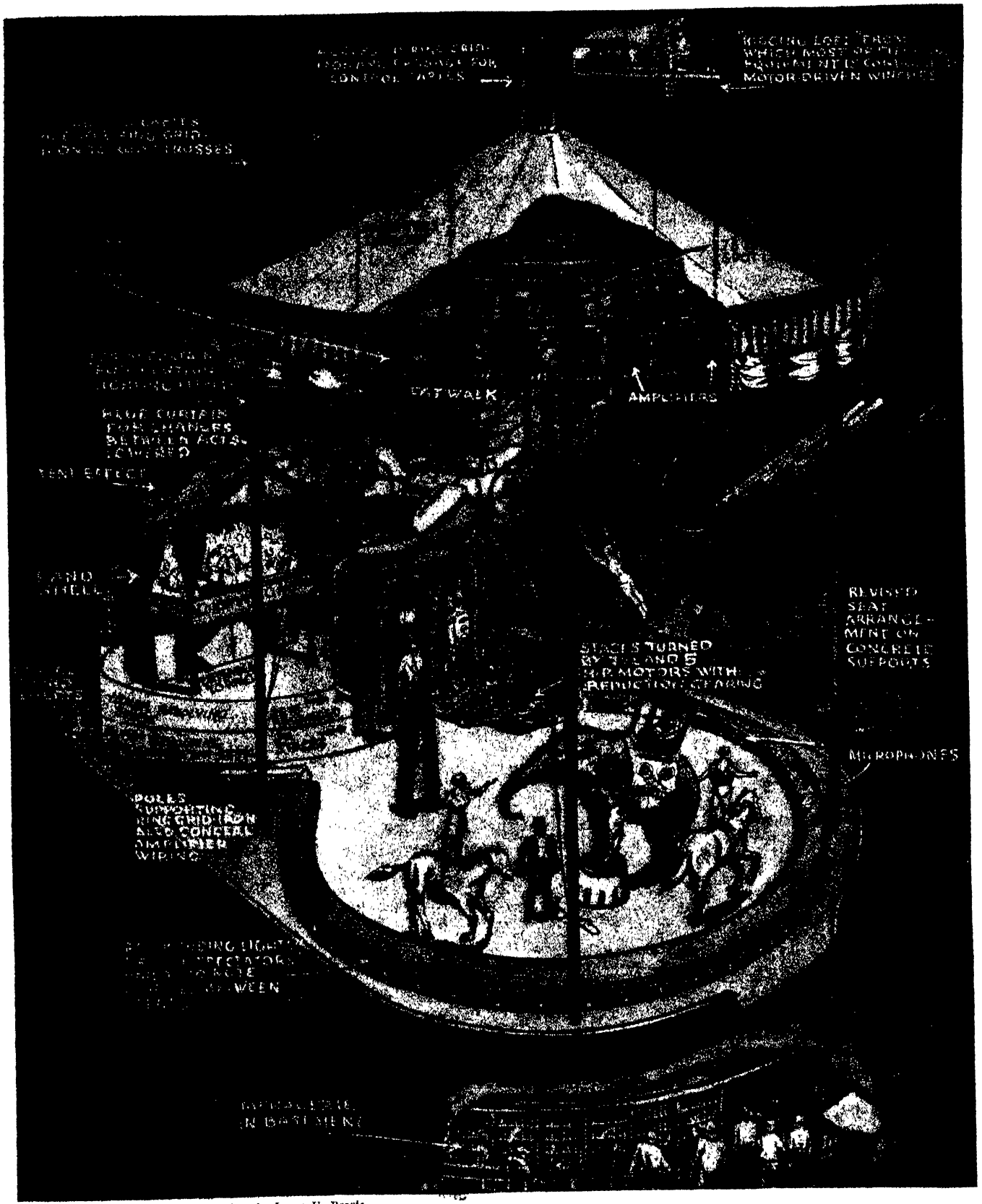
The maximum power—52,200 shaft-horsepower—is based on a piston speed of 1800 feet per minute and a brake-mean-effective pressure of 130 pounds per square inch. That these values are within the limits justified by present practice is shown by the results of two recently built German engines.[2]

A Maybach V-12, Büchi-charged engine, built for the new three-car trains on the Berlin-Hamburg run, is given a maximum rating of 1834 feet piston speed and a brake-mean-effective pressure of 142 pounds per square inch. An Augsburg engine with a cylinder diameter of 11.81 inches—which is materially larger than the engine here proposed—has a maximum rating of 1743 feet piston speed and a brake-mean-effective pressure of 136 pounds per square inch.

These engines are built for a service in which the conditions are much more severe than those for naval vessels. In traction service, full power is demanded for short periods every day; and, at the end of a year the number of hours during which full power had been used would be enormously greater than in

(*Please turn to page* 53)

[2] *Gas and Oil Power* (London), March, 1935.



Drawn especially for Scientific American by Logan U. Reavis

The "Big Top" in a Theater

"LADEES an' Gennelmen! The big show is about to start!" And a big show it is—the circus that appeals to kids of all ages has, by the exercise of ingenious engineering design and construction, been set up in the famous old Hippodrome in New York City. At a production cost estimated to be about 200,000 dollars, some 700 seats were removed from the orchestra, a complete circus ring was installed as shown, and two of the largest revolving stages in the world were built. The seats on the main floor were rebuilt and supported on reinforced concrete sloping upward at an angle that affords an unobstructed view of the ring to everyone. The circular gridiron is one of the notable mechanical features. It permits rapid handling of scenery and also affords space for the location of the lighting fixtures. From it is also suspended the aerial acrobatic equipment. It is planned that the show will eventually go on the road in large theaters and under canvas in smaller towns.

RUBBER TAKES THE

Persistent Rubber Research . . . Product Sticks to Old Jobs, Does Them Better . . . New Uses . . . New Research . . . Potentialities for the Future

A thin trickle of milky fluid from incisions cut in the rubber tree makes its way, through research, into great industries where it is now indispensable

DAMPING out the physical shocks of a highly mechanized world is still the major function of rubber. But there are properties aside from vibration absorption which give high rank to this strange, natural resin. Persistent refinement has multiplied types manyfold so that today rubber can be applied in ways undreamed when the first crude, bulky gum shoes introduced it to man's service.

Rubber is now safeguarding airplane surfaces from the abrasive force of rain and hail and it is even being employed to protect air transports from the hazard of ice formation on wing edges. It is now lining metal tanks used for the shipment and storage of chemicals. And quite recently was announced the successful imparting of an antiseptic quality to rubber which should make it a much better qualified material for, say, surgical gloves.

Step into research laboratories to discover what manner of studies are being carried on; list the tangible accomplishments in the past few years and you will find that the significant work with rubber has been mainly one of establishing better controls over materials and processes. Months and years of laborious, penetrating research have brought out the many latent characteristics of rubber. It can be worked at will to produce a product hard or soft, more or less flexible, highly resistent to chemicals, more durable, or perhaps to combine several qualities in chosen proportion. The main advance in rubber has been to make it deliver better service and nothing illustrates this fact so well as the automobile tire.

An automobile tire, regardless of its price, represents a skilfully developed product. Few articles in the public's hands are subjected to such savage abuse and expected to like it. And that it does "take it" is proof of high attainment. There have been no revolutionary changes in tire construction in many years, yet the tire of today gives double and sometimes triple the mileage of one produced only a few years ago. Extraordinary wear has been built into the product and even so the makers are not satisfied. Tires will be made even better through the agency of research.

Today's tire is a balanced product; it is a compromise and must be so. Perhaps you think wear could be increased by adding more rubber to the tread, or perhaps you think it should cushion better or skid less. No single quality in performance can be altered without affecting all the others. Cornering, the quality which permits adequate steering control; cushioning, which is the quality of flexibility; and durability, which is what gives life, are the three main factors governing tire performance. To establish a satisfactory balance between these factors has taken years of study and experimentation. If more rubber is added to the tread it affects both cornering and cushioning factors; if cornering is improved by giving more rigidity to the carcass it affects cushioning, while if more flexibility is provided so that bumps can be "swallowed" better, the steering qualities are changed. Actually, there does exist a state of unbalance but of a different sort. A tire carcass, if undamaged, outlasts the tread.

CHEMISTS are trying to solve this state of unbalance by compounding rubber to give it longer wearing life without sacrifice of other qualities, and, strange to say, there is research being conducted to improve the carcass. Experiments are being made with rayon as a substitute for cotton in the manufacture of tire fabric. It is claimed that rayon shows a better resistance to the heat which is generated internally, but as yet the right type of rayon hasn't appeared. Militating against any prompt substitution is the present superiority of the carcass over the tread and the large amounts of capital which tire manufacturers have tied up in cotton fabric mills.

Assuming that tire casings can be made to last longer in service and go to pieces all at once (without hazard), there is always the inner tube to threaten trouble, and a puncture-proof tube is a perennial dream. Puncture-proof tubes have come, been punctured, and then gone into the discard, ever since there were such things as tires. One doubts the possibility of ultimate success. From the earliest types, which employed such odd materials as feathers and molasses, there have been some advances. The newest devices on the market are three in number. One utilizes a double inner tube, the innermost one of fabric, designed to slow the passage of air in case of a blowout and permit the car to be brought safely to a stop. Another employs a substance which floats freely in the tube and is supposed to be thrown centrifugally into a puncture aperture.

SHOCKS OF INDUSTRY

By PHILIP H. SMITH

The third is a tube with the rubber in compression, ready to close any hole that should be made in it.

One solution to the present disparity between carcass and tread life is re-treading. It is, however, a makeshift and one that tire manufacturers as a whole do not view with approval. During the past two years re-treading has made great headway and it cannot be wholly ignored. It is now possible to re-tread a tire to make it deliver close to double the regular mileage, due to certain technical advances such as the development of delayed accelerators, the flat cure, the circular (clamshell) mold and the advent of large-diameter tires. The make-shift of it becomes apparent when it is realized that re-treading requires a sound carcass for satisfactory results and there are proportionately very few tires which come up to standard. If cords are cut with a nail, if the cords are broken by running against sharp obstacles, or the fabric is broken down by running under-inflated, re-treading is not only unwise but uneconomical.

Rubber research, which has put the world on cushioned wheels, has not stopped with tires. That has provided merely the foundation. As one moves upward from tires to chassis and body of the present day motor car, one gets an appreciation not only of the penetration in the automotive field, but hints of broader applications. One of last year's lowest priced cars boasted the use of more than 164 pounds of rubber, and this figure is certain to rise because a still newer model in the low-priced group claims 400 distinct rubber applications. Springing is being rubberized to a point where ultimately metal may be done away with altogether. Bodies are being insulated from chassis, engine mountings are universally featuring rubber in some form, and almost every place where there is movement and contact of metals is being cushioned. Coming in for greater attention is the possible use of rubber universal joints to cushion the drive between transmission and wheels. In this application, the technical problem has been to get a device that will not overheat under severe operating conditions and will hold the drive shaft in alignment at all times.

A NEW use for rubber in the automotive field, heralded as a desirable departure, would make it a bonding agent in the manufacture of brake lining and clutch facings. It has been brought forward in an attempt to get away from the present ply construction. The bonding agent is introduced during the weaving process and a heavy type of lining, which is later compressed to form, is woven. The bonding compound is the factor governing the frictional quality of the lining; hence, by varying the compound at will, low or high friction qualities can be imparted to suit specific needs.

IN order that laymen — and even scientists are laymen in fields outside their own!—may keep close tabs on the doings in widely separated branches of industry, we have presented a number of Mr. Smith's articles during the past year. This is the tenth of his fine reviews in which he correlates facts, evaluates them, and points out the possible (or probable) future.

Do you like these articles? Have they given you the new insight into industry that they aim to give? Are they valuable in building your store of knowledge? Have they helped you solve some of your own problems?

Scientific American is edited for you. Help us edit it better by giving us the answer to those questions. We would greatly appreciate it.—*The Editor.*

Coming into wider commercial use is sponge rubber, the first experimental applications being for seat cushions, arm rests, and panel insulation. It is being used quite successfully as an inner tube for heavy army trucks and armored cars where puncture-proof characteristics are more to be desired than easy riding qualities. Its adoption for seat cushions is being held up because, in its present state of development, it weighs more than the orthodox spring type cushion, but a solution of this handicap is hinted at as being met by combining sponge rubber with rubberized spun hair. There is already on the market a rubber-insulated hair cloth which is fabricated into loops forming a series of figure eights. This is being employed in the openings between metal springs of an inner-spring type mattress to distribute weight more evenly and eliminate the need for tufting.

Revolutionary and much desired would be rubber fenders, as any one will agree who has driven in metropolitan centers. Except for buses, rubber fenders are impractical at this stage. Reinforcing steel would be required to give form, and mountings would likewise have to be of metal with the net result of much added weight where weight is undesirable. What we do see coming into use is rubber fender liners to reduce noise and prevent flying stones

Believed to be the largest rubber lined hose ever constructed: a dredge discharge hose 30 inches in diameter in 18-foot sections with rubber end-flanges

Valuable data on tire wear are learned from this test. Tires are pressed against the revolving, cog-rimmed wheel with a pressure equal to normal road weight

and gravel from denting the metal surface.

Now that the automobile has given rise to the development of satisfactory sound and vibration dampers, other types of transportation vehicles are adopting them. A French rail coach mounted on pneumatic tires was recently demonstrated in this country; light inspection cars have tried out solid tires for high speed running, while domestic rail cars obtain freedom from jar through a method of assembling rubber rings under compression into the wheels. Even the crawler type of tractor has been utilizing rubber, substituting for the steel track-laying band a continuous rubber belt with blocked-off tread design, reinforced longitudinally with steel cables. It is claimed that the rubber belt type of drive takes half the power of the ordinary steel track, while speeds as high as 50 miles per hour are possible.

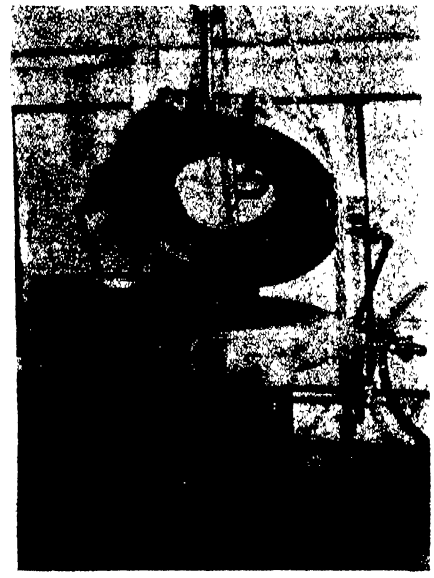
No metal touches metal in this rubber-insulated spring shackle

Many of the rubber applications found on transportation equipment are suitable in modified form for industry, but the truly significant industrial use stems from the development of processes to affix rubber to metal with an inseparable bond. This discovery has made it possible to line tanks for chemicals, to cover pipes which are to be buried underground, to combine metal springs and rubber for suspensions, and to mount heavy machinery with more effective vibration dampening.

Several types of rubber-to-metal bonding processes are now in commercial use. One process involves the plating of the metal with brass and then vulcanization of the rubber to the brass. Another method employs a series of binders beginning with one that will adhere to metal and ending with one which bonds with rubber, the intervening binders being ones which will bond with each other and thus by transition unite the two extremes. One of the metal-binding rubbers was discovered quite by accident. Treating rubber with certain acids produced a new compound, named Thermoprene, having extraordinary tenacity in clinging to anything in contact. It is a rubber compound and not a synthetic rubber such as Duprene, Thiokol, and Koroseal, which have been described already in these pages.

One of the outstanding uses for the rubber-to-metal bond is to make shock and vibration dampers for heavy machinery units. One type of damper comprises two pieces of metal with rubber bonded between in the form of a sandwich. One metal piece is fastened to the floor, the other to the machinery and the vibrations are taken through the rubber in shear. This sandwich form also serves for automobile engine supports. Another version is used for supporting the weight of a street car on its trucks. Here there are two cylindrical rings of steel with a third ring of rubber between them and bonded to them. The inside ring is raised above the outer ring so that the load is applied to the rubber in shear. In more complex forms, design is such that additional deflection under loads brings greater amounts of rubber into action.

Of the several applications of rubber-to-metal in shear, those which have to do with cushioning vehicles are the most obvious, but the opportunities to apply this new development to factory machinery are practically unlimited. There are advantages to be had in damping down vibrations for the comfort of the people working within the factory walls and also a great saving in wear and tear on the building proper. It is difficult to figure in dollars and cents the losses to industry from the incessant shaking given to its workshops, but the factor of building depreciation is known to be large enough to warrant extended use of these new vibration absorbers.



The full-circle retreading mold for used tires as discussed in the text

To reach its present high state of development as a suitable lining for metal tanks and tank cars, rubber has been required not only to adhere to metal without impairment due to the contraction and expansion following temperature changes, but to withstand wetting and drying and permeation of the liquid contents. Under most conditions the lining must not alter or discolor the contents and should the lining be damaged inadvertently it must be possible to make repairs easily and inexpensively. That rubber linings meet all these requirements bespeaks a great accomplishment for rubber chemistry. But if this is unconvincing, try to tear off rubber that has been bonded to metal.

Crude rubber has been put to uses which are startling because departing so widely from the expected. On many counts it vies with rubber latex for headlines. Employing it as a filler for the expansion joints in concrete highways is a new use with possibilities. Anyone who has driven over concrete

following a hot day has known that joint filling material left something to be desired. Expansion forces up the asphalt to form ridges to the distraction of the motorist and the detriment of the highway. Once squeezed out there is no return of the material, so sponge rubber was conceived as the material that would overcome this defect. Rubber filling returns to its normal position when the slabs contract, thus permanently keeping out water and dirt.

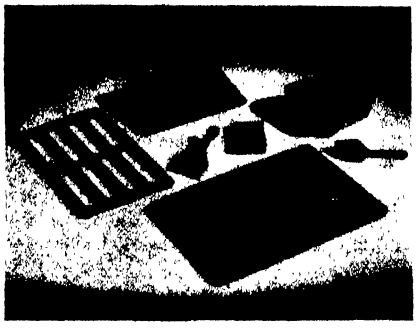
ANOTHER recent application aims at safety rather than comfort. It is a de-icer for aircraft. It is simple but effective, comprising three rubber tubes placed longitudinally along the wing. The middle tube centers on the leading edge, while the other two are placed below and above it. When atmospheric conditions cause the formation of ice, the middle tube is inflated by compressed air and simultaneously with its deflation the other tubes are inflated. The performance is repeated in rapid sequence to produce a rocking effect which cracks the ice so that it is blown away. This de-icer is a small affair, involving nothing that has not been available for a long time, yet it solves a problem which has worried airplane designers, owners, and operators.

The employment of rubber as a paint base has already been discussed at length in these pages.[1] However, in the months intervening since details were given of the hydrocarbon derived from crepe rubber, and of the chlorinated form, development has been carried forward swiftly to work out practical applications, to determine what the base is best suited for and the proper materials to be used in combination with it.

Most of the really practical accomplishments with rubber have been achieved by intensification of inherent properties through chemical treatment. Now comes something radically new. Rubber has been given a property that it never possessed in its natural state and that property is antisepsis. It is almost too soon to talk about this scientific achievement, for although it is in practical use it has hardly emerged from conclusive tests. Originators of this product claim that the quality of antisepsis is given to rubber through actual chemical change of the rubber molecule. Further claims for this rubber are (and they sound almost unbelievable): killing of bacteria, inhibiting bacterial growth, capacity to change acids to alkalies.

[1] Scientific American, April 1935, page 194.

Boulder Dam type trucks weighing 60,000 pounds give tires much punishment hauling loads of coal over jagged mountain roads from a strip coal mine

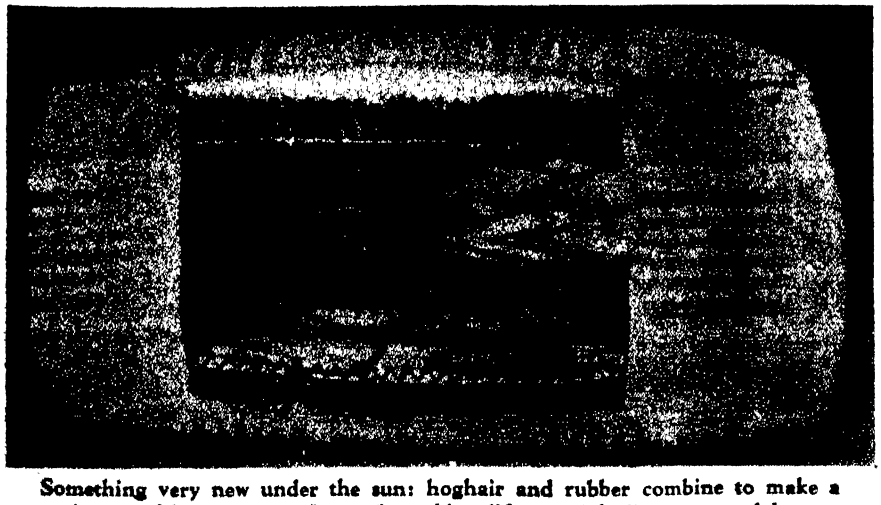


Hard rubber has recently found many uses in a variety of products

One can imagine a wide field for this particular rubber and it occasions no surprise to learn that it is being used now for surgical gloves and for such protective products as dress shields and baby pants.

CHEMISTS are somewhat divided as to the potentialities of present research. There are some who hold that the rubber-sulfur base must be abandoned if any marked progress is to be made; others believe that painstaking research along established lines will yield adequate returns. It seems likely that there is some truth in both. Rubber is at the point where years of laborious study may yield a sudden unpredictable discovery, either as a radical departure from the present course or as a logical step in it.

Chemists have no illusions about the vastness of the unknown and they are attacking rubber chemistry from many angles. More study is going into antioxidants to prolong the useful life of rubber; search is being made for new and better reinforcing pigments; new compounds are being evolved and tested; and control of reclaiming processes is being bettered to the end that used rubber will be more uniform and better suited to the many uses to which it is being put. The process of refinement is unceasing and rubber flowers into forms which promise to give it an even wider play in commerce and industry.



Something very new under the sun: hoghair and rubber combine to make a springy, tuftless mattress. Note the rubber "figure eights" at top and bottom

Photographs courtesy *India Rubber World*, *S. A. E. Journal*, B. F. Goodrich Co., and U. S. Rubber Co.

A Bigger and Better

CAPE COD CANAL

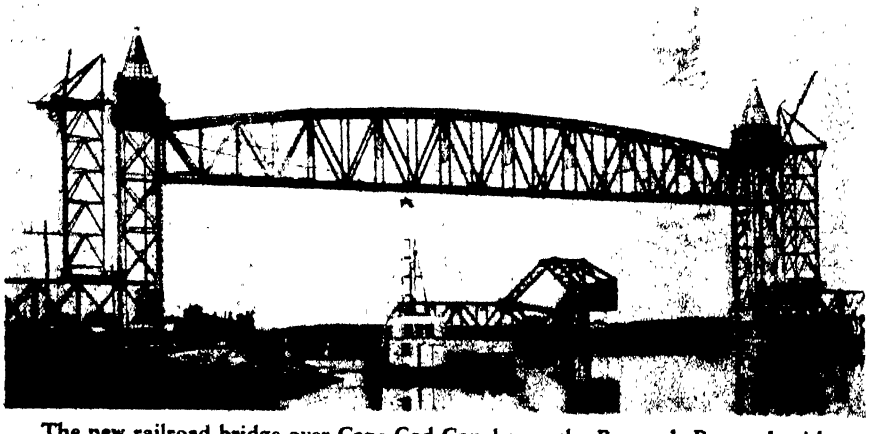
By R. G. SKERRETT

CAPE Cod Canal is now undergoing changes that will allow it to accommodate annually the movements of shipping carrying substantially 10,000,000 tons of cargo—about five times as much as that man-made waterway has averaged yearly since the Government bought it in March, 1928. Depending upon the route followed by a craft in approaching Boston from the south, the canal saves from 65 miles to 166 miles, and effects fuel economies ranging from 50 to 200 dollars a trip. But, what is equally important, the sheltered run through the canal renders unnecessary the navigating of Cape Cod's dangerous offshore waters that each year costs on an average the lives of fifteen people and property damages of more than 500,000 dollars.

The Pilgrim Fathers, more than 300 years ago, urged the digging of a canal to connect Cape Cod Bay with Buzzards Bay, separated by a sandy peninsula less than eight miles wide. The wedding of those two bays was not effected until July, 1914, when the Boston, Cape Cod and New York Canal Company cut through the final intervening barrier of earth. The canal was accepted as finished by the Commonwealth of Massachusetts in April, 1916, by which time dredging had produced a channel 25 feet deep, with a bottom width of not less than 100 feet. At that time, the waterway represented an expenditure of 13,000,000 dollars by the canal company.

As a wartime measure, the Government took over the canal in July, 1918; and later purchased it for 11,500,000 dollars, immediately making it a toll-free route. The waiving of tolls added to the popularity of the waterway; during the first year of Federal ownership 1,405,782 tons of cargo passed through the canal. The latest published statistics show that 2,804,998 tons of cargo were carried over that route in 1933, and indicate a steady increase in the use of the canal.

The canal was intended to obviate the offshore run around the cape through waters where shifting shoals, deceptive currents, dense and frequent fogs, and seasonal gales have long had to be reckoned with by craft engaged in coastwise trade. In the two decades from 1900 to 1921, 974 vessels were wrecked in the waters about Cape Cod, and the property losses totaled about 10,000,000 dollars, while 300 lives were snuffed out. Yet, despite the seeming advantages of the shorter and safer route via the canal, figures reveal that only about 20 percent of the water-borne cargo moving in and out of Boston, between that port and ports to the south, is carried through the canal. It is to change this situation for the greater security and convenience of coastwise commerce that the Cape Cod Canal is undergoing radical and noteworthy changes.



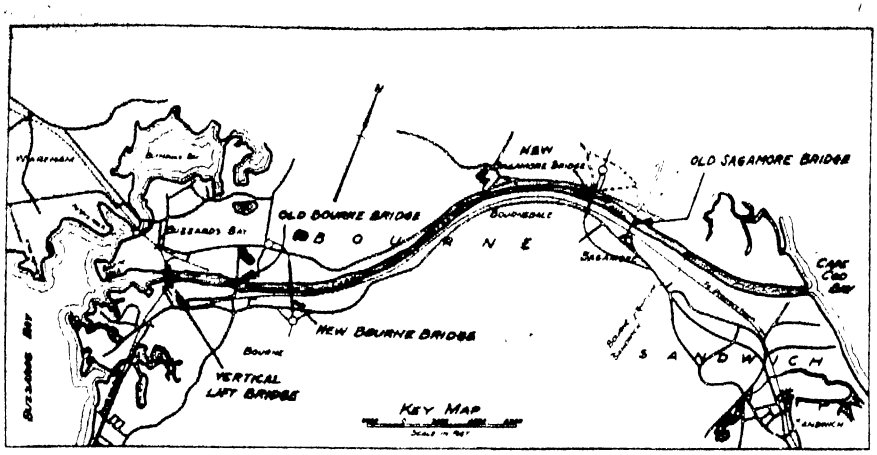
The new railroad bridge over Cape Cod Canal near the Buzzards Bay end, with its great lift span in raised position. Its clearance above water level is 135 feet

Cape Cod Bay and Buzzards Bay are so surrounded by land that the tide wave that flows in from the sea does not reach the innermost sections of those bays simultaneously. It is high tide in Buzzards Bay more than three hours before the water in Cape Cod Bay arrives at the same stage. Further, while the rise and fall of the tide in Buzzards Bay is normally through a range of close to four feet, the corresponding movement in Cape Cod Bay is in excess of nine feet. These differences of level between the two bodies of water cause currents in the canal that have velocities up to more than five miles an hour. These currents tax to the utmost the skill of the man at the wheel.

From November, 1915, to June, 1930, there were 75 recorded accidents in the canal and most of them were groundings caused by these tidal currents. The estimated damages—not all being recorded—totaled more than 800,000 dollars. The same currents eroded the canal banks, and created shoal areas. Well-nigh continuous dredging by the Government has failed to restore the channel to its original depth, and vessels drawing in excess of 20 feet of water do not use the route. These circumstances make it understandable why so many shipmasters take the seaward course around Cape Cod.

IT was manifest that the canal should have a deeper and wider channel, and it was proposed that locks should be constructed at the Cape Cod Bay end of the waterway to produce a currentless or slack-water route. Locks are objectionable wherever traffic is heavy, because they entail delay. The Government technicians, therefore, have abandoned the plan to build locks for reasons to be explained later, one of which, unforseen, came to light in the construction of new bridges over the canal.

More than 5,000,000 dollars is being spent on three new bridges to supplant the three old ones that were built by the Boston, Cape Cod and New York Canal Company. The two new highway bridges were finished recently, and the new railroad bridge is nearing completion. All the old bridges are of the bascule type and low. Well-nigh all of them have had to be opened to permit vessels to pass. The opening and closing of these bridges have alternately arrested land traffic and water traffic. The two new highway bridges, however, have channel spans that afford a vertical clearance of 135 feet; the spans are so long between their two supporting piers that there is ample room for the broadening of the channel to the projected splendid width. Each one of these new bridges carries a road-



Map of the Canal showing the old and the three new bridges

way 40 feet broad, designed for four lanes of motor vehicles, and a sidewalk six feet wide.

The new railroad bridge is of the vertical-lift type, the lift span measuring 544 feet between the points where it engages the guideways in the two supporting steel towers, each of which is 275 feet in height. The lift span will travel vertically a total distance of 130 feet, and can be raised or lowered to that extent in two minutes. When in the fully raised position, the span will be 135 feet above the surface of the canal; and ordinarily this greatest of lift spans will be held aloft for the convenience of shipping and will be lowered when the relatively infrequent train is to cross the canal. The channel between the pier fenders of this bridge will be 500 feet wide as compared with the opening in the old railroad bridge which is but 140 feet.

THIS brings us to the reasons for continuing the canal as an open sea-level waterway. Cape Cod and the neighboring region is gripped occasionally by winters of exceptional severity; the winter of 1933-34 was one of that kind—with ice 18 inches thick formed in the open, wind-blown waters of Buzzards Bay. If the waters of the canal were stilled by locks and exposed to the low temperatures, they would freeze quicker and thicker in their sheltered course than the waters in Buzzards Bay. Such heavy ice would inevitably block the canal and the locks, and prevent either the opening or closing of the lock gates. But there is still another reason for the abandonment of the plan for locks.

In excavating for the foundations for the three new bridges, numerous boulders were encountered, some of them weighing many tons; and the presence of those, buried more or less deeply in the prevailing sand and gravel, added greatly to the difficulties of preparing the pier foundations and likewise increased the cost. The area traversed by the canal is what is known as a glacial terminal moraine, and the reasonable assumption is that the geological conditions at the proposed lock sites would be similar to those at the bridge pier sites. To build locks and support them properly in such ground would be so expensive as to make them undesirable; hence the course now being carried out was adopted.

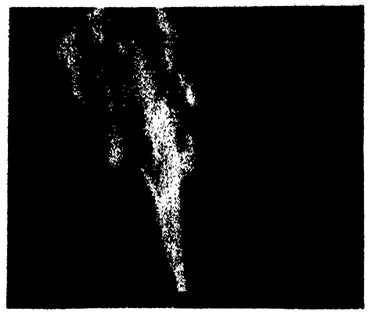
To make the canal an adequate route for a much greater volume of shipping than has used it up to the present, the Chief of Engineers has endorsed the plan that calls for a land cut that will provide a depth of water of 32 feet and a channel with a bottom width of 540 feet—more than five times its original width. The channel has latterly been broadened to 205 feet, with a marked improvement in its navigability. From the western end of the canal, a new and nearly straight channel 500 feet wide and 32 feet deep is to be dug in Buzzards Bay to a point westward of Wings Neck. From that point to deep water, the channel will be 700 feet wide. This new channel is to take the place of the old sharp-angled and considerably narrower channel, 5.3 miles long, that now constitutes the western approach to the canal. There will be a capacious mooring basin in the canal near its Cape Cod Bay end; another large mooring basin outside the western end of the canal at one side of the new channel; and a channel 100 feet wide and 15 feet deep will connect the Buzzards Bay channel with Onset Bay to the westward. Onset Bay will provide a land-locked haven for yachts and other small craft. At present a vessel skirting Cape Cod can find no harbor or refuge or protecting lee between Provincetown and Marthas Vineyard, 110 miles distant.

Heretofore, traffic has been put through the canal alternately from one end of the waterway to the other, and sizable vessels have not risked collision by passing in the canal. When the new channel is completed across the peninsula, it will be reasonably safe to maintain two-way traffic simultaneously and thus add tremendously to the value of the waterway and to its capacity to serve shipping. The Army engineers, under whom the work is being done, believe that the wider and deeper channel between the two bays will bring about adjustments of levels that will reduce the head or slope that causes the currents and, to that extent, make the guiding of vessels through the canal an easier task. This, in combination with the much broadened route, will prove a boon to shipmasters and dissipate objections to the canal that have prevailed in the past.

APART from providing a safer, shorter, and better route than the offshore one, where dense fogs occur more than 1000 hours annually, it should be remembered that the Cape Cod Canal is destined to serve as an important link in the intra-coastal waterway, which is now partly completed. That waterway will eventually afford a sheltered, inland course for vessels of certain kinds, among them pleasure craft, moving up and down the seaboard between the Gulf of Mexico and the ports of New England. Any way it is viewed, the Cape Cod Canal should stand forth as an engineering undertaking of the first magnitude, and one that will benefit the entire nation.

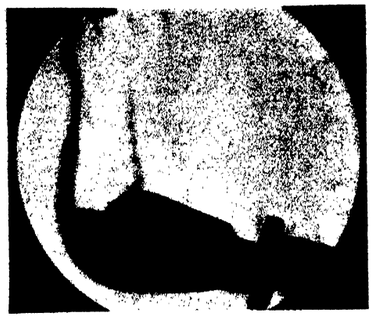
Air view of the fine new Sagamore Bridge which has a clearance of 135 feet above the waterway. Just beyond is the old one that is to be demolished very soon

Ether vapor rising from a small vessel, vaporization being hastened by an air jet blown over the ether from the right

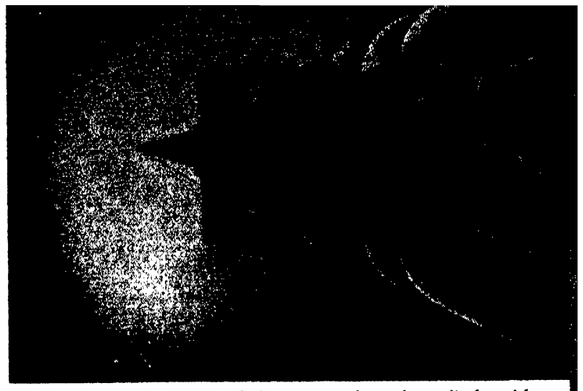


A stream of warm air rising from the hot flame of a burning tallow candle

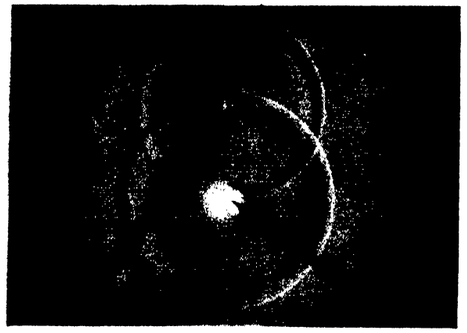
A striking illustrati ws the complexity of the sound waves a bullet passes between two parallel plates (two black lines) reflect the he waves, in a manner similar to light reflected from a mirror. Note turbul behind the bullet



An electric incandescent bulb and reflector send up a stream of warm air



Sound waves from a bullet passing through a cylinder with ope ings at the sides, as revealed by means of "streak" photograph



Large and small sound waves spreading from sources (sparks) giving sounds of different values

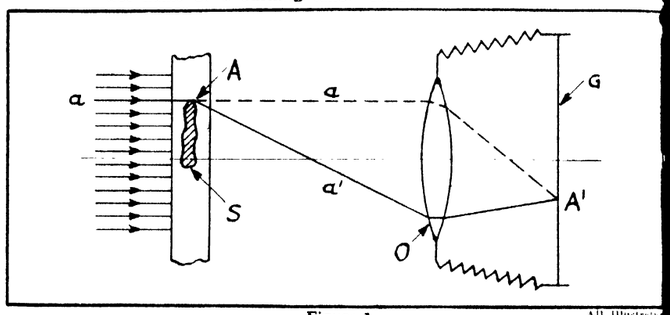


Figure 1

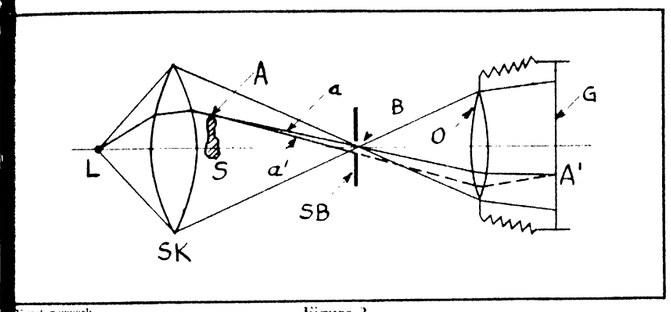
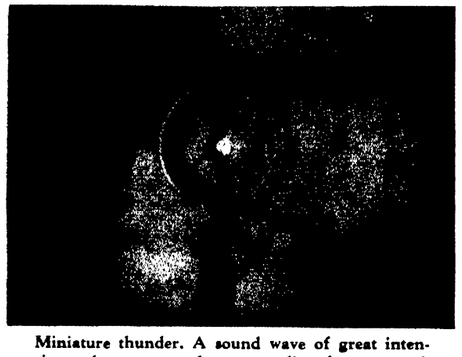


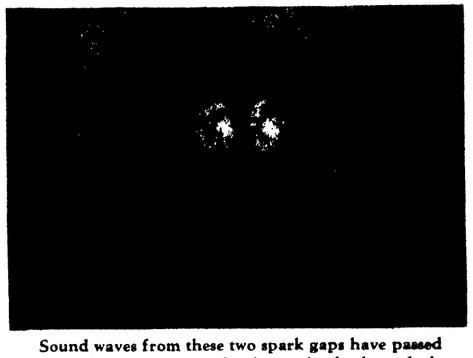
Figure 2

All Illustrati Kerstonewyork

Two sound waves spreading simultaneously, and practically independently, from two spark gaps



Miniature thunder. A sound wave of great intensity and steep wave front spreading from a spark



Sound waves from these two spark gaps have passed beyond camera range, leaving only the heated air

er being poured from a bottle, the heavy carbonic acid gas dying above the glass and descending in waves alongside

A bubble, rising to the surface of a glass of carbona water, has just burst, and the vapor is being pushed

'SEEING' T INVISIBLE

By DE B ERSTON

THE ability to photograph certain phenomena in the fields of acoustics, ballistics, flow-physics, heating, and so on, is of tremendous value to the research worker. By means of the "streak" method, which may be used in both still and motion-picture photography, such photographs may be obtained as are reproduced on this page.

In order to understand the streak method of photographing invisible phenomena, it is helpful to remember the effect, so often seen on hot days, of railroad tracks in the distance seeming to wriggle under the scorching sun. We all know that a beam of light, passing from an optically denser medium to a thinner one (or vice versa), is refracted. Now, in the case of the railroad tracks, warm air forms eddies above the hot rails as it rises, because hot air is less dense than cold air. And because the density of the warm air is constantly changed by cool air currents pressing from the sides, a beam of light from any point of the rail has to pass alternately through layers of warm and cool air, which means that it is continually more or less refracted. This has the effect of making a section of rail appear to bend either up or down, more to the right or to the left. In similar manner an object viewed throug a poor grade of window glass, whic is composed of irregular sections (thic er or more curved areas), is apparentl distorted.

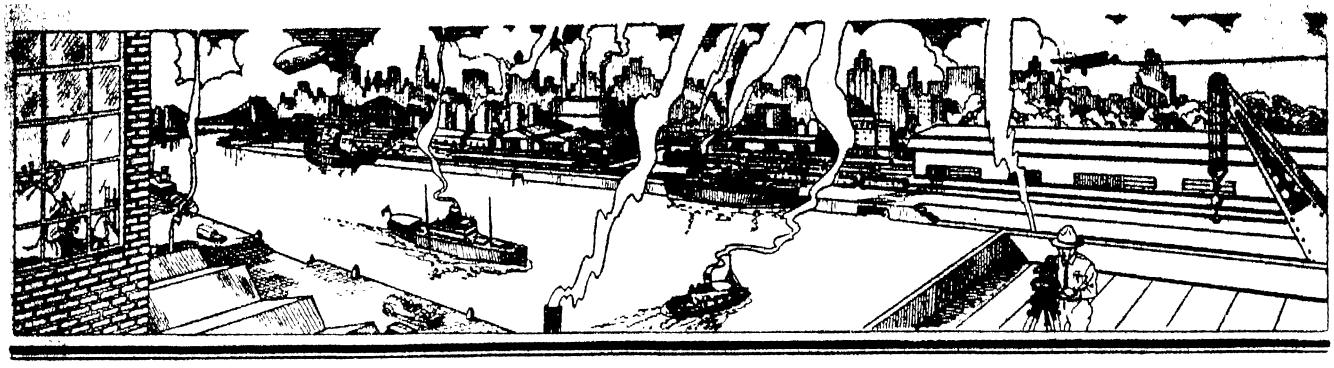
Generally, uneven areas in a mediu are referred to as "striae" or "streaks Thus a sound wave is a streak, becau the propagation of sound depends the spreading of various densities of th air. Another example is gasoline or eth vapor in the air. The streaks themselv are invisible, and their effects are see by the human eye only when they cau distortion of light rays coming to th eye from an object of known shape. is possible, however, to photograph the streaks, as explained below.

A typical streak in a glass pane illuminated, in Figure 1, by parall light rays. At point A the beam strongly refracted (a') through th margin of the streak. If we now foc the camera sharply on the window pa (and thus also on the streak), the r fracted pencil of light a', through th effect of the lens O, appears on exact the same spot A′ of the ground glass if there were no streak at all, and as the beam had not been refracted. The non-refracted ray is marked a.) onsequently, the point A′ on the ound glass has the same luminosity tensity of light) as if no streak were esent. In other words, the ground ass is evenly illuminated all over, and e streak cannot be seen.

If, however, the refracted rays are duced or "stopped down" by means a diaphragm, so that they cannot mpletely pass through the objective, e streak becomes visible. In order to op down the refracted rays evenly, the rangement shown in Figure 2 is usuly employed in principle. With the d of a concentrated light source L d the lens SK, a convergent pencil of ght is produced, which has its focal oint at B. Behind B the camera (obctive O with ground glass G) is aced, and focused sharply on the int S, where later on the streak (for ample, ether vapor) is to be placed. If a single ray of light strikes the ound glass at the point A′, and a eak is placed at the spot S, the ray is then refracted downwards and folws the path a'. But it also reaches point A′ due to the optical reproduction of the lens O, and because of this fact the streak remains invisible.

However, it will be seen that the ray a', the same as any other ray refracted by the streak, no longer passes through the point B. If a circular stop SB is now placed close to B, ray a' is stopped down (the subdued part is shown as a dotted line), and likewise every other ray that has been refracted by the streak. Consequently, the point A′ now appears darker on the ground glass. The same happens with light passing through any other point of the streak, varying, of course, in accordance with its refractive power. Thus, the entire streak appears on a light background.

Actual procedure naturally requires certain modifications in the diagrammatical set-up shown here, because certain assumptions, which we have made to elucidate the process, do not exist in practice. The technique of this process was discovered in 1864 by the eminent physicist Toepler, and has been named after him "Toepler's Striae Method." But it is only in recent years that this method has been practically applied in many branches of industry and science.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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In charge, Daniel Guggenheim School of Aeronautics, New York University

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Lehigh University

Frost Chaser

THE mechanical frost-dispeller pictured here is a typical example of new equipment found in a limited number of California orchards. It is installed on the ranch of A. H. and R. W. Hills in the Porterville orange district. A 450-horsepower 12-cylinder Liberty airplane engine drives an 8-foot propeller. The engine and propeller are mounted on a 40-foot steel tower, the platform of which slowly revolves when the engine is running. The spinning blade creates a wind, circulates the cold air that always settles close to the ground, and nowhere in a 40- or 50-acre area can Jack Frost find a quiet spot to lay down his white mantle.

Courtesy *Standard Oil Bulletin*

An airplane propeller and engine help protect orchards from frost

Soap versus Soapless Soap

FOR many years the manufacture of soap proceeded along conventional lines with but slight change due to technological developments. Suddenly, however, the soap market was threatened by the development of the so-called "soapless detergents," the sulfated higher alcohols of the fatty acids, with their remarkable properties of lathering freely in even the hardest waters. Originally of foreign origin, these processes and products have been studied and improved through the work of a number of American companies, notably Procter and Gamble, Du Pont, and the National Aniline and Chemical Company.

The soap industry, stirred by this infusion into its ranks of organic chemistry of a new order, has counter-attacked along several lines. One of these was the use of sodium hexametaphosphate as an adjuvant to soap. This is said to put old-fashioned soap on a basis where it can compete in performance with the results obtained with the higher fatty acid sulfates and at a lower cost. Thus, a challenge raised by chemical research in one direction is met by chemical counter-attack.—*A. E. B.*

Constructing World's Largest-Bore Tunnel

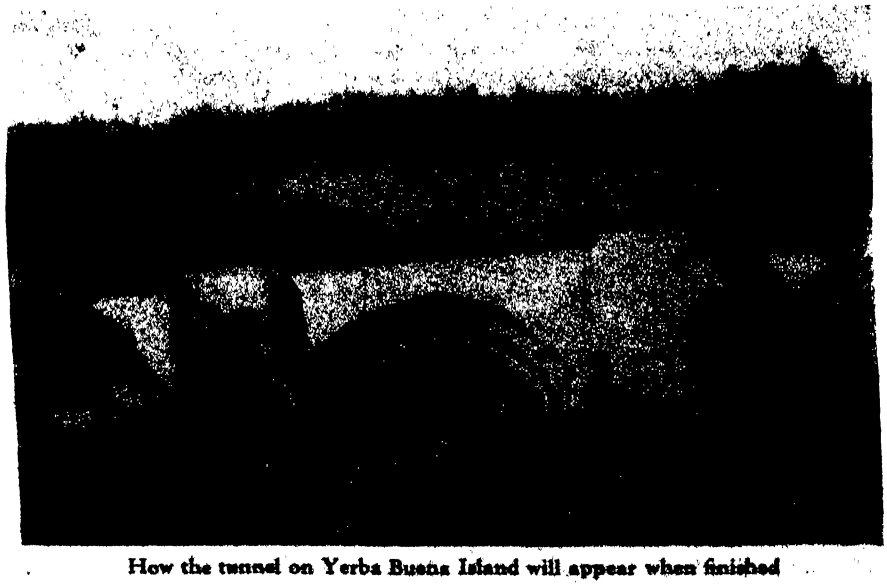
MORE than 350 feet of the 540-foot Yerba Buena Island Tunnel of the San Francisco-Oakland Bay Bridge is now completely lined with concrete of a minimum thickness of four feet on its side walls and a minimum thickness of three feet over its crown, according to Chief Engineer C. H. Purcell's last report to State Director of Public Works Earl Lee Kelly.

The crossing of Yerba Buena Island, a military and naval reservation, occupying a 400-acre outcropping of sandstone, is by means of a reinforced concrete viaduct, four 288-foot steel truss spans, and a 540-foot tunnel.

The main vehicular tunnel, without its concrete lining, will be 76 feet wide by 58 feet high, making it the largest-bore tunnel in the world. It will accommodate two traffic decks. The upper deck will have six lanes for fast automobile travel; the lower deck will have three lanes for heavy trucks plus two tracks for interurban trains.

A tunnel was chosen for this portion of the work rather than an open cut because the very high and steep side slopes of the latter would have created the hazard of dangerous slides. In addition, such a cut would be a restriction to the best use of the island by the government agencies occupying it, and would have created an unsightly scar.

In constructing the tunnel it was anticipated that the rock for the first 200 feet from the west portal would be somewhat broken and incapable of supporting itself. Cement grout under as much as 300 pounds pressure was pumped into 25 1½-inch holes which were bored horizontally into the rock and over the crown of the tunnel before any digging was started. By this means the rock was sufficiently strengthened.



How the tunnel on Yerba Buena Island will appear when finished

When completed, the tunnel will be continuously lined. The roof will be supported by 16-inch steel arch ribs spaced every three feet. This steel will be embedded in concrete with a crown thickness of three feet.

Due to the large cross section and short length of the tunnel, no mechanical ventilation is provided.

In the construction of the main vehicular tunnel, the open portals at both the east and the west ends were first excavated.

A novel method of excavating the world's largest bore tunnel was conceived by Chief Engineer Purcell and his staff, the novelty of which consists chiefly in that they first build the tunnel and then dig it out.

Three bores were drilled through the island for the tunnel. The three bores, one at each lower side and one in the crown, are blocked out into a horseshoe-shaped excavation through the rocky island. This horseshoe-shaped excavation is then concrete- and steel-lined from three to five feet thick before the inside or core of the tunnel is dug out.

With the tunnel completely lined for most of its length of 540 feet, a power shovel enters the portal to remove the thousands of cubic yards of rock within this 58 by 76-foot bore. Through this bore a four-story building could be pulled upright. —*California Highways and Public Works.*

Taking out the core of the Yerba Buena tunnel, after the lining is in place

SMOTHERING FISH

FISH can smother in a lake and have actually done so in one up near Wallingford, Connecticut. A correspondent to the journal *Science* says that water plants absorbed most of the oxygen from the water so that the many fish living therein died in gasping agony.

Extinguish Oil Fires with Water!

WATER is being used successfully to fight oil fires, the National Fire Protection Association reports. The water-for-oil-fire method, which apparently breaks basic rule No. 1 of fire-fighting techniques, is illustrative of progress and research in the fire-extinguishing field, says the Association.

The new oil fire-fighting method consists of a fine spray of water forcibly ejected from special nozzles installed in sprinkler pipes or on a hose. The secret of success seems to be that the spray droplets must be of a critical size; if too large, they splash the burning oil and spread the fire; if too small, they cannot extinguish the flames. So don't rush out and throw water on the next oil fire you see.

Although not yet submitted to fire underwriters' organizations for final testing and approval, installations have already been made for the protection of electrical oil transformers and high-pressure oil systems. —*Science Service.*

Blood Test Before Marriage

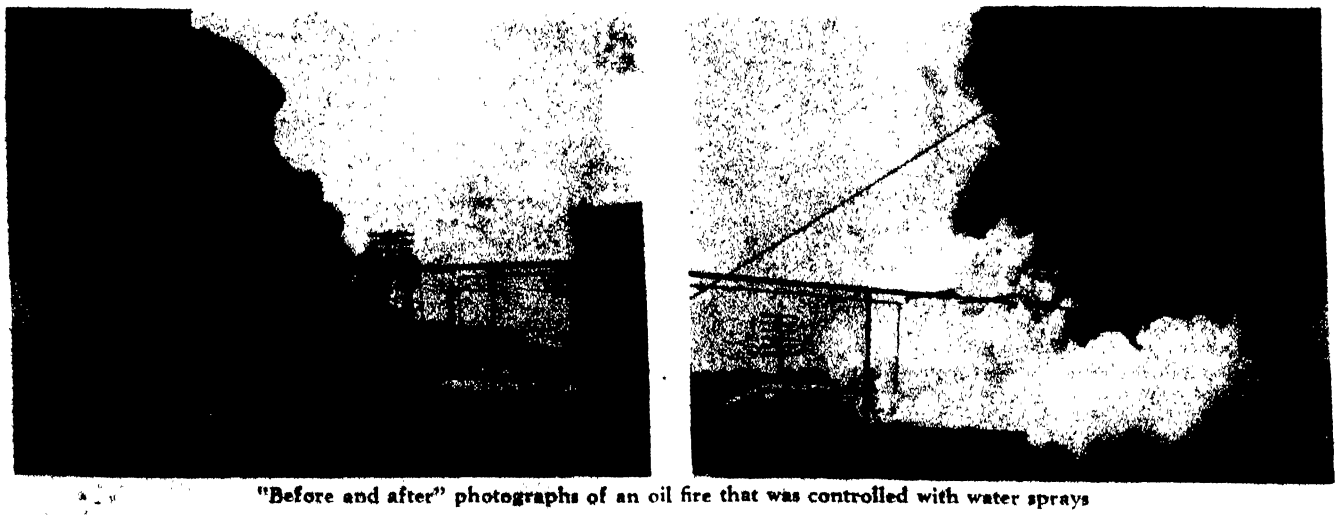
AFTER the first of January, all applicants for a marriage license in the State of Connecticut must pass a Wasserman or Kahn test before a license will be granted. The certificate must be based on a blood examination by an approved laboratory. The blood examination will exclude the possibility of the dreaded venereal disease, syphilis, which in certain stages is readily communicable. Other states requiring medical examination upon the issuance of a marriage license are Wisconsin, Oregon, North Dakota, Alabama, Wyoming, and Louisiana. North Carolina repealed its law last year.—*Science Service.*

EARTH TIDES

MOON tides in the earth's crust? Yes, scientists have shown that such is the case, and their delicate instruments have proved that Pittsburgh rises and falls from 13 to 23 inches a day.

Pacific Airline Bids Accepted

AIRLINE operation by Pan American in the Pacific will probably be in effect by the time this issue reaches the reader. Postmaster James A. Farley has accepted the Pan American bid for carrying airmail across the Pacific. The bid calls for a maximum rate authorized by law of two dollars a mile for a specified 800-pound load and one dollar a pound for each 1000 miles in excess of 800 pounds carried. This means



"Before and after" photographs of an oil fire that was controlled with water sprays

that the Post Office will pay a maximum of 17,200 dollars for each flight across the Pacific, or slightly more than 50 cents a letter when a full mail load is carried.

The specifications call for weekly trips each way between San Francisco and China, with Hawaii, Midway, Guam, Wake, and the Philippine Islands as the intermediate points.

Pan American was the only bidder so there was no question of competition but only a question of whether the six-man cabinet committee would accept the one bid. It may seem at first that the possible bill of 1,665,000 dollars a year to the United States would be generous, but it is not undue remuneration when the size and cost of operation of the huge China Clippers are considered, and when we remember that Pan American has spent 4,200,000 dollars on its preliminary preparations in the Pacific.

The inauguration of this service will be another stepping stone in the progress of world aviation.—*A. K.*

A Flying Club-Car

A BOEING 247-D high-speed airplane has been recently delivered to the Phillips Petroleum Company. It is very tempting to look at a photograph of the interior of this

Inside the flying club-car

ship which contains such luxurious appointments as overstuffed easy chairs, built-in radio, and telephone communication between cabin and ground stations. To cruise at 200 miles an hour in such a cabin certainly appears very attractive.—*A. K.*

A Tailless Private Airplane

WE have often had occasion in these columns to speak of the experiments which are being conducted under the auspices of the Department of Commerce in the construction of planes suitable for the private flyer. Definite information regarding these experiments is somewhat slow in forthcoming; however, we now have a description and the essential data on the *Arrowplane*, which has been built on the Pacific coast by Waldo Waterman, an experienced constructor and aviator.

Like the Hammond Model Y described in our October issue, the *Arrowplane* has its main wheels behind the center of gravity, and an auxiliary wheel ahead of the nacelle or fuselage. This type of landing gear makes for stability in taxying on the ground and is of assistance in side or cross-wind landing, lessening the possibility of the unpleasant "ground loop." At the same time, by virtue of the front wheel the flier can land his machine, apply brakes violently without nosing over, and stop in a very short distance, even if his approach to the ground is *not* the correct one. Obviously these factors are likely to be helpful to the novice pilot. The pusher arrangement, with engine in back, makes for excellent vision, and the noise of the engine and propeller does not bother the passenger.

These features have already appeared in the Hammond. The Waterman *Arrowplane* embodies certain other interesting departures from conventional practice. Thus the machine has no tail surfaces in the usual sense of the word. The wings are swept backwards, and at their outer and rear extremities the movable surfaces can be depressed or raised simultaneously (in which case they act as elevators) or given opposite displacement on either side (in which case they act as ailerons). These control surfaces are balanced by small external wings, sometimes called paddles (like those used on the Dornier *DoX*) which are placed well ahead of the hinge line of the control surfaces. The mechanical arrangement for the dual function of these control surfaces is not so complicated as might at first appear, and has been very well realized. The fins and rudders are disposed at the outer tips of the wings. The two rudders are operated one at a time. Thus if the rudder on the right tip is displaced outwardly, its increased drag tends to turn the machine to the right, and at the same time the side or "lift" force on the rudder also tends to turn the machine to the right. Conversely, outward displacement of the left rudder yaws the machine to the left. The two rudders can also be displaced inwardly simultaneously; in this case they cease to be rudders and function merely as air brakes.

The advantage of such rudder arrangement is that the rudder is never blanketed or rendered ineffective no matter how high the angle of attack of the machine may be, and therefore remains effective even if the machine is spinning. Stalling and spinning tendencies are also lessened by the

Waldo Waterman in the cabin of his tailless airplane. See the text

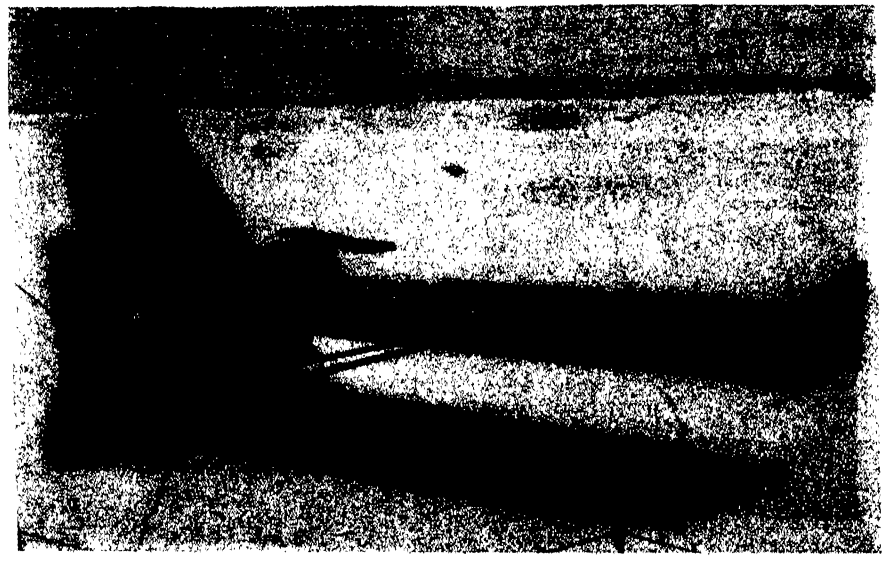
low loading per square foot of wing area.

The criticisms likely to be made of this type of aircraft, as of the Hammond Y, are that it is likely to be slower than a conventional machine of similar weight and horsepower, and that the public objects to pushers.

The main characteristics of the *Arrowplane*, as supplied to us by the manufacturer, are as follows: Maximum speed, 110 m.p.h.; range, 350 miles on 26 gallons of gas; weight empty, 1310 pounds; gross weight, 1900 pounds; span, 40 feet; overall length, 18½ feet; landing with stick all the way back, without leveling out, within 500 feet of an obstacle 35 feet high.

The American public is enamoured of the automobile, and the *Arrowplane* has tried to follow automobile practice inside the cabin. With the new landing gear, a very low slung cabin is possible, and the position of the seats, doors, and so on, follows motor car practice.

Newspaper stories also tell us that the wings will ultimately be made detachable or folding, and a gear drive introduced from the pusher engine to the rear wheels. In other words an attempt will be made to



Looking down on the Waterman *Arrowplane*, designed for private flyers

build a combination airplane-automobile.

Whether this last plan is seriously entertained or not, and whether the *Arrowplane* lives up to the first favorable impression, it certainly merits careful study by designers and fliers.—*A. K.*

An Airport Directory

THE first airport directory of the United States, dated 1935, has appeared, and comprises over 200 pages, listing airports by states, giving main dimensions and facilities, and including photographs from above of all the main landing points. The utility of such a volume to all aircraft operators and owners is obvious. A knowledge of airports is as indispensable to private flying as an understanding of air maps. Perhaps some day maps and airport directories will be distributed from aerial service stations in the way automobile maps are given away by the generous oil companies!—*A. K.*

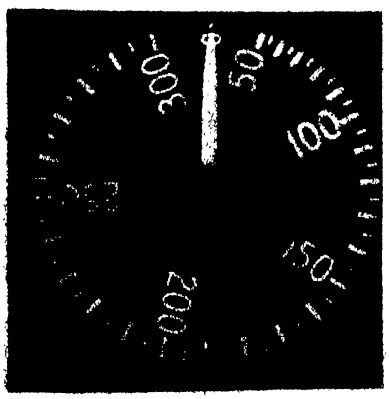
Visibility in Meteorology

WHEN the Weather Service was being organized for the airmail in Canada, the question of suitable visibility marks became a serious problem, as there appeared to be no general text on the subject of visibility. A very intensive search of the literature of the subject was made and the results published in Middleton's monograph, "Visibility in Meteorology," published by the University of Toronto Press.

From a practical point of view, when the visibility is very low, as in a real fog, air transport is greatly handicapped. While the book does not offer practical remedies, it does tell all that is known about visibility the behavior of light in the atmosphere, the appearance of objects, the calculations of visual range, and the dependence of visual range on other weather elements.—*A. K.*

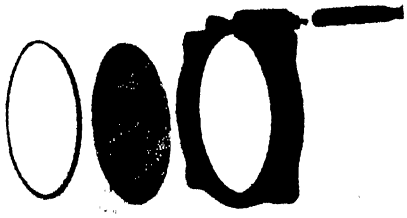
Ring Light for Aircraft Instruments

ILLUMINATION of instrument dials is an important matter in flying. Reflection or glare results in eye strain, delays reading of instruments, and diverts the pilot's attention from other duties. The luminous painting of dials is not satisfactory especially at dusk and dawn, and an additional source of illumination becomes necessary. The Pioneer ring light has been designed to eliminate these difficulties. The ring light employs a glass rod curved around the circumference of the instrument dial. The glass rod is so constructed and treated that light is carried around the periphery of the dial and is distributed evenly over the dial markings and the end of the pointer. The result is a soft, even light without glare or bright spots, regardless of the angle from which the dial is observed. A small electric light bulb is the source of light, and a resistance unit is built into the plug so that the instrument may be connected directly to the lighting circuit. After the ring has once been installed, the snap ring, pointer, dial or, if necessary, the movement, may be removed without disturbing the lighting system.—*A. K.*



How the dial of an air-speed meter shows up with ring light

The Navy amphibian, *XP3Y-1*, that recently set a new non-stop flight record



Parts of the instrument ring light

A Navy Seaplane Record

THE international record for non-stop flight for a seaplane was recently broken by Lieutenant Knefler McGinnis, U.S.N. and a crew of five in the Navy amphibian *XP3Y-1*. The flight took them from the air base at Coco Solo, Canal Zone, to San Francisco, California, and covered an air-line distance of 3300 miles.

This is not just another record, but an important demonstration of the speed and endurance which can be counted upon in our newest patrol boats. Sixty of the new type seaplanes will be built by the Consolidated Aircraft Corporation in San Diego, California. When the Navy has these staunch patrol boats backed up by two fast tenders and the two new 20,000-ton aircraft carriers, the *Enterprise* and the *Yorktown*, its vast air patrol fleet in the Pacific will be remarkably efficient and effective.

Little detailed information is available on the *XP3Y-1*. From the photograph it is clear that not only is an amphibian gear incorporated in the design, but the tip floats also retract into the wing in flight. Another interesting feature is the way in which the engine nacelles have been arranged close together so that the propeller tips almost touch.

It may be noticed that the horizontal tail surfaces are very high out of the water, as a help in rough seas. One peculiar thing that we may surmise from our illustration is that the tip floats swing out outward and form a tip extension to the wing. Swinging outward in this fashion is, of course, an easier mechanical problem than raising the tip floats upwards into the wing as has been the practice hitherto.—*A. K.*

Roof Top Landings

JAMES G. RAY, of the Autogiro Company of America, is one of the most experienced and skilful 'giro pilots in the world. He has recently added to his list of exploits by landing on and taking off from the roof of the new Philadelphia Post Office, flying mail to and from the airport. The machine employed was a small two-seater cabin plane of only 75 horsepower. The landing area on the roof was only 365 feet long running north and south, and 288 feet wide. The problem was complicated by the presence of pent-houses on the east and west sides, some 16 feet in height, which housed the ventilating machinery, elevator machinery, and other mechanism of a large building. Such machinery is generally housed in haphazard fashion on a roof top, and its enclosure in the pent-houses was a concession to aircraft landing needs. There were also parapets at the north and south ends, about four feet in height, but these obstacles were minimized by sloping the roof surface at each end to meet the top of the parapet walls.

Even with these obstructions, and in spite of the restricted area of the roof, and in spite of the currents always present in the disturbed skyline of a great city, no particular difficulties were encountered. It may now be taken for granted that while autogiro operation on large roof tops will call for skill and considerable practice, such operation may be considered as entirely practicable. The possibilities of such operation in hastening airmail deliveries are obvious.

This is an age of streamlining; planes, automobiles, trains, and ships are all subjected to this process. Mr. Ray, writing in *Aviation*, points out that streamlining may also be applied to buildings.

On the windward side of a structure, an upward current of air may generally be expected. In fact it is the upward current of air on the windward side of a hill which is so frequently utilized in glider soaring work. An upward current of air at the edge of a building may also be expected on a sunny day because warm air always tends to rise. A paved courtyard at the base of a wall exposed to the sun's rays will naturally give rise to a more violent upward current than an area planted to grass or shrubs. A strong wind, or these upward thermal currents, will cause eddying or air disturbance at the edge of a roof. The moral

is that the pilot must stay away from the edges.

Similar troubles are of course experienced on aircraft carriers, and the landing area of a carrier may be gently curved at its end. Mr. Ray suggests that the tops of buildings might be rounded off to minimize the effects of winds or thermal currents. If the edges were provided with an aerodynamic deflector or guard, the otherwise harmful currents would be converted into helpful horizontal ones. The subject merits further exploration in the wind tunnel. At any rate, here is another application of aerodynamics for architects and inventors to consider. Besides being aerodynamically helpful, such devices might conceivably be made to have architectural merit.—*A. K.*

Nondehiscent Lily—Patent Applied for

IN its history the General Electric Company has had countless patents filed by its engineers and scientists. Now it is invading a new field in the government patent office. C. N. Moore, of the G-E Research Laboratory, has applied for a patent on a "nondehiscent regal lily." Appropriately enough, the flower in question is, at least temporarily, being called the Roentgen regal lily for it was among X-rayed bulbs of ordinary regal lilies that the new form was found.

The term "nondehiscent" means that the anthers of the flower do not open and shed their pollen. Ordinarily the commercial growers of regal lilies must pluck the pollen-laden anthers of the flower promptly, for

C. N. Moore examining a nondehiscent lily from X-rayed bulbs

the anthers quickly swell and burst after the flower has opened, shedding a wealth of golden pollen that sticks tenaciously to the white petals, more or less ruining the flower for display or commercial purposes.

In the spring of 1931 Mr. Moore, investigating biological effects of rays, treated bulbs of regal lilies with varying doses of the rays. Of 100 bulbs obtained from a commercial grower, 25 were kept as controls; 25 were subjected to 30 milliamperes and 200,000 volts at 20 inches for 15 seconds; another 25 were given similar treatment for 30 seconds; and the final 25 were so treated for a minute. The bulbs were then planted in a Long Island garden.

The untreated bulbs grew into normal plants that year. Among the treated ones were a few monstrosities—deformed stems, twisted and misshaped flower petals, and similar defects—which offered no desirable possibilities; the other treated bulbs seemed to have produced normal flowering plants.

The results were different the next season, however, when plants and flowers grew from embryonic structures present the previous year at the time of raying. Progeny of two of the bulbs that had received 30-minute doses of X rays produced flowers with non-shedding anthers.

Each succeeding year has seen the new strain continue true. Bulbs and bulblets from these two bulbs treated in 1931 have continued to bear nondehiscent flowers—the property is now considered as a fixed character, and the Roentgen lily is now established as a variety of the regal lily.

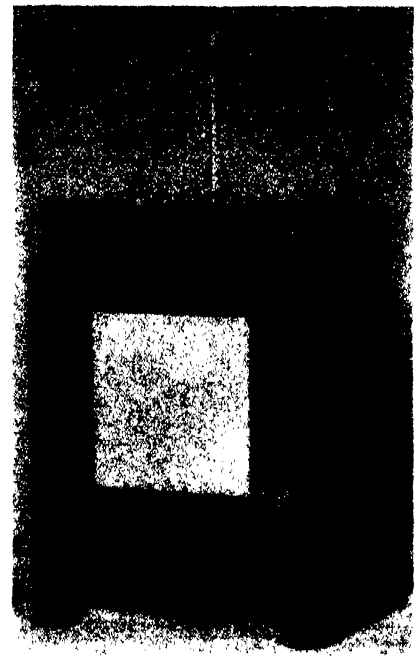
"Investigations with X rays in biological fields have long showed that surprising mutations and variations are to be expected if living cells are subjected to bombardment with X rays," says Mr. Moore. "If something happens to a chromosome of an egg cell or a young pollen grain when it is approaching maturity, it is likely that a 'sport'—offspring with different characteristics—will be produced. Such 'sports' occur spontaneously, and more or less rarely, in nature. Such happenings are increased in number many hundredfold when the single cell encounters the shattering force of the X-ray beam and the electrons which it releases."

The nondehiscent regal lily is but one of a multitude of biological changes which have been effected in the G-E Research Laboratory with X rays and cathode rays. Abnormalities of many kinds have been observed in a wide variety of plants, but the new variety of the regal lily is the first to which the phrase "patent applied for" has been appended.

Inexpensive Bacteria Incubator

DESIGNED for the microscopist who needs a high grade piece of equipment, but who does not have a great deal of cultures to take care of at one time, a new incubator has the added virtue of being inexpensive. It is particularly suitable for the private physician's office, for the advanced amateur, and for school laboratories.

It is built of metal, oak finished, and is double-walled. The insulation is a combination of the best grade of mineral wool and thin aluminum sheet. The aluminum sheet is very effective in preventing heat losses due to radiation. This combination produces a unit with very slight temperature variations between different levels of the interior. The thermostat is a commercial unit which is produced in large quantities but is extremely sensitive. It holds the temperature of the incubator to + or —.5 degree, Centigrade. The use of this commercial thermostat and this type of insulation makes it possible to market this incubator at a price unusually low for a unit of this type.

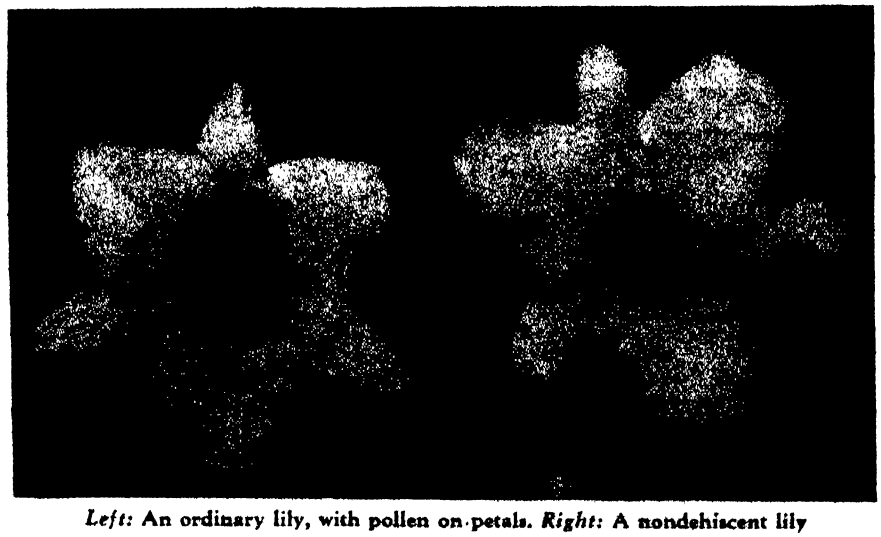


The inexpensive bacteria incubator designed for use by microscopists

The interior is 12 inches high, 9 inches wide, and 7½ inches in depth. It is equipped with an adjustable ventilator and a neon pilot lamp. The power consumption is less than 25 watts.

Refrigeration with Steam

STEAM is turned to ice in a fraction of a second by the vacuum method of refrigeration, the latest developments in which were described to American Chemical Society members at a recent meeting by D. H. Jackson of the Croll-Reynolds Engineering



Left: An ordinary lily, with pollen on petals. *Right:* A nondehiscent lily

Company. Live steam flows through small jets at extremely high velocity (4000 feet per second) into a condenser. As the steam expands coming from the jets, it cools instantaneously, the loss of heat being so rapid that icicles are said to form at the end of the jets.

Since its recent commercial development, this refrigerating process has been extensively applied for producing chilled water used in air conditioning of railroad cars, restaurants, theaters, and so on.

When first developed, the process required high-pressure steam from industrial boilers. Recent improvements include adapting it for low-pressure steam available from small heating boilers.

Industrial applications of the process are numerous, including chilling of yeast cultures and wort in breweries, mash and whiskey in distilleries, fruit and vegetable juices in canning plants, various chemical solutions, oils, milk, and the like.—*A. E. B.*

Micro-Movies

THROUGH the co-operation of the Bausch & Lomb Optical Company and the Eastman Kodak Company, a new apparatus has been designed for making microscopic movies. The use of the 16-millimeter camera has previously been somewhat limited in the scientific field. The cost of fitting up a movie camera to make microscopic movies ran well over the thousand-dollar mark and was limited more or less to 35-millimeter cameras and film.

Now the Cine-Kodak Special may be used with a special observation eyepiece which acts as a beam splitter. The beam splitter eyepiece is fitted to the front of the camera in place of the regular camera lens. In the beam splitter is a 45-degree prism, silvered but unbacked, which causes part of the light to be reflected to the film and part to be transmitted through the eyepiece so that the operator can observe the action and the field while the picture is being made.

New and inexpensive set-up for taking micro-movies, described here

Not only can films be made in black and white, but with the new Kodachrome film pictures in natural color can be obtained. The use of color film with polarized light produces some extraordinary results. The growth of crystals of organic compounds in regular and slow motion, filmed with polarized light, gives a mixture and change of color in the crystals of extraordinary beauty. Doctors, medical students, and scientific workers can make records in monochrome or color, for purposes of record, teaching, or scientific study. The amateur, at modest expense, is enabled to secure films of the activities of live specimens.

Snow Garlands—Meteorological Rarity

FROM a reader, Edmond P. Gibson, of Grand Rapids, Michigan, the editor has received the following:

"I am enclosing two photos [one of which is reproduced. *Ed.*] of a strange freak which occurred outside of my office window. Briefly, this is what happened: A heavy layer of snow formed on the porch railing and on a windy day of alternate freezing and thawing, it slowly tipped toward the building as if to fall. The following day the temperature held at 32 degrees. Fahrenheit, and the garland slowly lowered under the alternate conditions of momentary freezing and thawing. In the afternoon it snowed and a second layer replaced the first on top of the railing, while the garland continued to lower. I snapped the pictures in the afternoon and the following morning the wind destroyed the freak.

"I examined the remains of the garland to see whether there might be a string or something of a nature to act as a tension member or a reinforcement in the structure of this miniature suspension bridge. There was no such foreign substance in it and the necessary tension must have been furnished by the frost alone."

An unusual garland of snow, commented on by Prof. Humphreys

Mr. Gibson's communication was referred to Prof. W. J. Humphreys, physicist of the United States Weather Bureau, author of "The Physics of the Air" (standard reference book), and editor of *The Monthly Weather Review*, technical meteorological journal published by the Bureau. He finds that only four previous accounts of snow garlands are on record, and adds:

"What is the explanation of this holding of snow crystal to snow crystal in a continuous suspension bridge from anchorage to anchorage? Nothing, we are told, is more impossible than making a rope of sand, and yet of ice sand, that is, of snow crystals, Nature makes suspension bridges, or garlands, if we prefer art to engineering. How does she do it?

"The fact that these garlands do not occur when the snow is dry, but only when it

Occasionally the movies offer us something mentally stimulating and a case in point is "Transatlantic Tunnel," a recent G-B production. In this film, in which huge mechanical sets such as the one shown above were used, a tunnel is bored under the Atlantic Ocean from England to the United States, using a newly "invented" radium drill. The photograph above was taken looking into the set of the tunnel with the radium drill at the far end, and toward the lower right is shown one of the high-speed cars for transporting workmen to the working face

MOLECULES

MAKING big ones out of little ones (molecules) is one way of making gasoline. Natural gas and waste refinery gas are treated by the chemical process known as polymerization—which makes two or more molecules join and form a larger molecule—and the result is gasoline, benzol, toluol, and xylol.

is wet, from partial thawing, rules out the suggestion that the snow crystals, or flakes, cling to each other by irregularities on their sides and faces, like so many prickly-burrs. But while one suggested explanation is thus removed, another is so strongly supported by the same facts as to compel its acceptance. This is, that the snow crystals, being wet, are strongly drawn each to its adjacent neighbors, by the surface tension of a water film, and thus through film and flake the whole snow-garland tenaciously held together from end to end.

"The following experiments are convincing of this: Take a lot of unglazed bits of paper, 1 to 2 millimeters across, and roll them together to the size and shape of a cigarette and try to suspend the collection from its two ends without other support. Immediately it falls apart like the fabled rope of sand. Roll them together again and then put enough water on them to make them wet through and through but not drippy. Now they are held together by the surface tension of water films and will hang nicely in a festoon supported at the two ends only. And as it is with the bits of paper so it is also with snow crystals. They fall apart when dry and cling together when wet. The garland is first formed of damp snow whose flakes and particles are held together then, and often for many hours thereafter, by the surface tension of water films."

SOY-BEAN PRODUCTION

FROM an acreage of 50,000 in 1907 to more than 5,000,000 in 1935 is the record made by soy-bean cultivation in this country. Thus production of this valuable farm product, brought here from the Orient, has increased a hundredfold in less than 30 years.

Portable U-V-Ray Box for Art Examination

THERE has been developed at the Metropolitan Museum of Art, New York, a small, readily portable, ultra-violet-ray producing apparatus which can be simply used, without danger to the operator, on either alternating or direct current. This equipment, which was developed by Mr. James J. Rorimer, Curator of the Department of Medieval Art, and which has proved very satisfactory in the routine examination of works of art, will also be valuable for the stamp collector, jeweler, geologist, and any one using the long-wave ultra-violet rays.

The box illustrated in the accompanying photograph was fitted with nine porcelain sockets which were connected in parallel and fastened to a plug which fits into the ordinary electric outlet. The box was made of sheet metal so as to conform to the Fire Underwriters' regulations and also for handling convenience. In the sockets were placed the ordinary blue glow lamps (argon mixed gas) which are produced by the General Electric Vapor Lamp Company. These lamps are said to be the "only source of near ultra-violet light which combines simplicity with cheapness." Over the front of the box is a slide opening which would hold the standard molded glass filter which is supplied by the Corning Glass Works. It is important to use the smoothly molded filter to obtain the best results. The red-purple, 5mm., Corex A, 986 is preferable to the Violet ultra, 686, for most examinations with ultra-violet rays.

The results to be obtained with this convenient apparatus are usually as satisfactory as those to be obtained with larger and stronger equipments requiring a mercury lamp, rheostats, and other complicated devices with which the average person is either not acquainted or with which he does not wish to bother.

Nine sockets and special lamps provide a handy source of ultra-violet

Speedy Fueling System for Army

THE practicability of 100 percent motorization of nearly every branch of the Army was proved in the maneuvers at Pine Camp, New York, according to army officials. The concentration of 36,000 men and officers at the area was accomplished largely by motor transport. Officials declined to reveal just how quickly this was done, but declared that it was accomplished in record time and with a minimum of confusion.

The maneuvers, the largest peacetime concentration in the history of the country, depended entirely upon gasoline-operated vehicles, not only for the transportation of supplies, but also for the movement of men, equipment, and guns. Trucks, tractors, tanks, armored cars and even taxi cabs were utilized in the movements that simulated actual warfare.

Army units were spread throughout the area, which covers over 100 square miles, at widely separated intervals, and it was necessary that trucks transporting food and supplies be fueled at various points at definite times so that the source of supplies be uninterrupted. In addition, tactical vehicles such as tanks, tractors, armored cars, and motorized artillery and machine gun units had to receive gasoline on schedule during actual maneuvers in the field.

To assure that this phase of the tactics was carried out effectively, a commercial oil company, in co-operation with the Quartermaster's Staff of the First Army, set up a system that employed 18 trucks which operated throughout the area, delivering Mobilgas at points dependent upon the day's moves. These trucks, which have a capacity of 1600 gallons each, loaded at four railheads and are capable of refueling vehicles at the rate of 100 gallons a minute. This speed is made possible by a specially developed system of four hoses, two of which are run from each side of the truck. One of each of these sets is run from the truck's pumps over portable hose racks so that two lines of vehicles may be fueled on each side of the truck at the same time.

Four lines of military vehicles may be refueled at once with this new system

New Cure for Stubborn Wounds

FROM a clue provided by an insect, entomologists of the United States Department of Agriculture have discovered a new way to heal stubborn wounds quickly, painlessly, and cheaply. The new treatment is the application of a solution of allantoin, a bland, odorless, harmless, and easily obtained product found in both insects and plants.

The insect that gave the clue to this discovery is one of the flies—in the maggot stage—that gained fame as a medical aid on World War battle fields, where an army doctor found that wounds infested with maggots healed better and faster than wounds without them. Since then surgeons all over the world have used maggots in treating deep infections difficult to cure by ordinary surgery. (See "In Defense of

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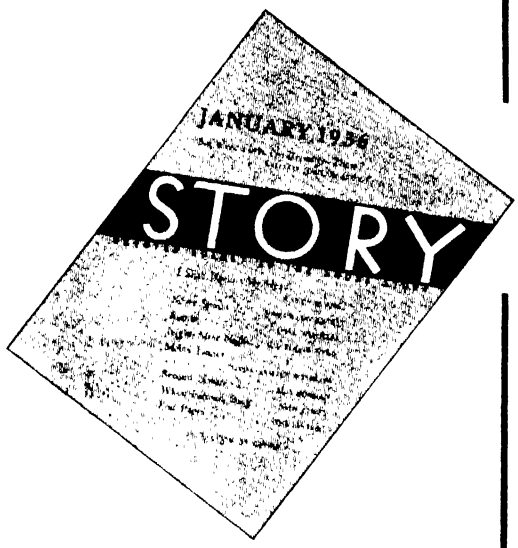

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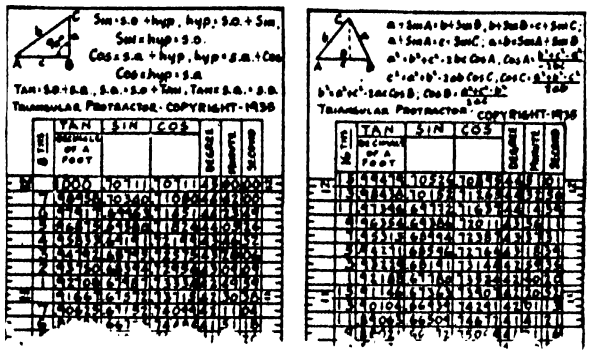
Insects," Scientific American, Sept. 1935, pages 124-126).

Government entomologists, who have developed methods for rearing and shipping sterile maggots to hospitals, have at the same time sought the secret of this maggot's power to heal. Dr. William Robinson, of the Bureau of Entomology and Plant Quarantine, now finds that allantoin, which is given off by the maggots as they work their way through a wound, is responsible for part of this power. Allantoin, Dr. Robinson says, is not a new discovery. Dr. C. J. Macalister, who used it successfully 23 years ago for ulcers, reported that European peasants had long applied the roots of comfrey, which contain allantoin, to sores.

Triangular Protractor

A NEW triangular protractor scale which eliminates the ordinary protractor and combines an ordinary scale (half full size); a decimal scale; a straight protractor with degrees, minutes, and seconds; a bevel, or slope, scale; and a trigonometric computer, has just been developed by Lew Koen.



With the new triangular protractor, part of which is shown at the left, it is possible to perform many mathematical calculations and to compute complicated figures

The Triangular Protractor Scale is a mathematical instrument for measuring and computing angles, triangles, complicated figures, roofs, and so on, accurately. It is based on the principle of triangulation with a base of 12 inches and altitude to correspond to the required angle up to 45 degrees; for angles between 45 degrees and 90 degrees, the 12 inch base becomes the altitude and the base is measured to correspond to the difference between the required angle and 90 degrees; for angles between 90 degrees and 135 degrees, the 12 inch base becomes the altitude and the base is measured to correspond to the difference between the required angle and 90 degrees and drawn adjacent to the 90 degree angle; for angles between 135 degrees and 180 degrees, the base is 12 inches and the altitude corresponds to the difference between the angle and 180 degrees—the difference and the angle are supplementary.

The decimals of a foot for each 1-8, 1-16, and 1-32 of an inch are given in the column marked Tan.

The following natural trigonometric functions are given: Tan (Tangent), Sin (Sine) and Cos (Cosine), and corresponding angles in degrees, minutes and seconds.

Ordinary problems in addition, subtraction, multiplication, and division can also be solved directly by use of the protractor allowing the use of even large numbers without complications.

"Whipped" Concrete

A HEAT insulating material with a heat-transfer coefficient comparable to cork may be produced from Portland cement, with or without the addition of mineralized wood fiber, by a process developed by the Porete Manufacturing Company. This product, known as Poretherm, is usually made in one of two weights, either 19 or 32 pounds, per cubic foot. It can be made in precast shapes, in the form of slabs and blocks, or it may be poured in the field. The 19-pound material is used for insulating refrigerated spaces and for high temperatures up to 700 degrees, Fahrenheit. Its crushing strength is 40 pounds per square inch. The 32-pound material is used for ordinary insulating and for fireproofing steel structural members. Its crushing strength is 150 to 200 pounds per square inch.

This material is mixed in an ordinary concrete mixer, using Portland cement and water to which Porete foaming agent is added. Without chemical action, air is whipped into the mixture to form a concrete containing great numbers of small air bubbles. For the 19-pound material the coefficient of heat conductivity is 0.37 B.t.u., and for the 32-pound material, 0.63, as compared with 0.30 for cork board.—*A. E. B.*

SAVAGE SALVAGERS

JUNK dealers of today had their prototypes in pre-Columbian America. Down in the Blue Ridge foothill country, Dr. David I. Bushnell, Jr., of the Smithsonian Institution, has found many ancient Indian axes and ax-like weapons which were salvaged and rechipped generations after they were first used. Scientists learn from this that there were two distinct long-separated periods of occupancy in piedmont Virginia.

Monitor Drawings Come to Light

WE quote below from a letter which we had intended to publish in our Navy Number but which had to be held aside for lack of space. This was forwarded to us by Mr. G. Emil Hesse, Narrkoping, Sweden:

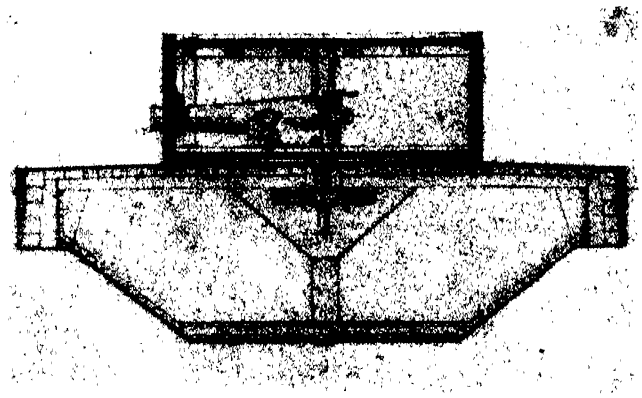
"Many people have no doubt wondered what became of John Ericsson's papers and other things. His parlor furnitures were donated to the Nordiska Museum in Stockholm. Everything in the drafting room was sent down to the office of the Ericsson Coast Defense Company's office, which was organized by some of his friends.

"I became the Consulting Engineer of the Company, and I bought everything in the drafting room, and sent it home to Sweden—instruments, drafting board, drawing table with two drawers full of drawings, but only three of the *Monitor*. One hundred and thirty drawings are at the Technical Museum in Stockholm as a loan.

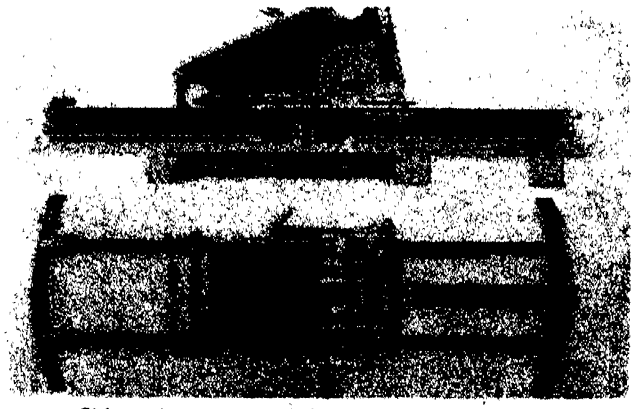
"They were exhibited in March last year to about 400 invited people, also the Crown Prince. They have never been shown

(*Please turn to page* 49)

Exterior of the *Monitor* turret



Cross-section of the *Monitor* hull and turret



Side and top views of the *Monitor* gun carriage

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Conducted by ALBERT G. INGALLS

WHO says the world isn't getting better? Suppose we have a look at it and see. Five years or so ago, when "Amateur Telescope Making" was just passing through its puberty, there were two great bugbears in the telescope making art—making pitch laps and silvering telescope mirrors. Then several men of science discovered a way to apply coatings of reflecting metal on glass by evaporation in vacuo and, as a result, far fewer mirrors are being silvered today than yesterday. Perhaps silvering is headed toward the gate. Bugbear No. 1—silvering troubles—has thus been largely disposed of.

And now Bugbear No. 2 is also on the way out. You whose dispositions have been wrecked by pitch lap making may make your salaam to four modest men in Pittsfield, Mass. and Bridgeport, Conn.—Everest, Munn, Morse, and Carlson, for these benefactors have now taken the bug out of the second bugbear. Thanks to them you can now make a lap in your sleep, that is as uniform and perfect as a waffle. The Pittsport Door Mat is the answer. The picture on the opposite page shows (bottom half) what the P. D. M. is like, and the series of pictures on the page you are reading shows just how it is used. It is a specially designed, specially made grid of flexible rubber which you lay on the glass tool, fill with melted pitch, strip off and, lo, your lap is made and without any of those idiosyncrasies which, as you well know, will somehow or other turn up in an ordinary pitch lap no matter how much profanity you direct at it while working on it.

Fig. 1—**The start**

Fig. 2—**The dams**

Fig. 3—**Pouring**

Fig. 4—**Poured**

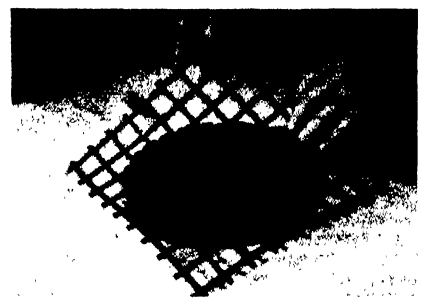


Fig. 5—**Peeling off**

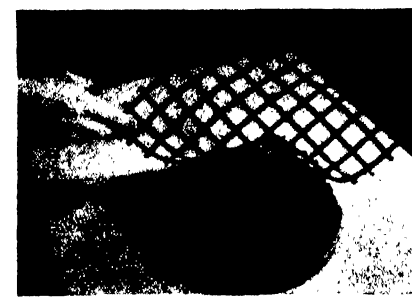


Fig. 6—**It doesn't stick**

Fig. 7—**Result**

Fig. 8—**Hardness test**

Closely examine the photograph on the opposite page. The mat, when ready for use, looks as shown at the bottom. Its thickness is 3/16", its size 12" x 12", and the grid is made up of members of flexible rubber cast in one piece and having a cross-section like that of a typical channel in a pitch lap—that is, ¼" wide at the side which casts the top of the channel, and about half as much at the side which lies on the glass tool and makes the bottom of the channel. The mat gives facets one inch square and all alike. When the door mats first come from the manufacturer there is a thin rubber web over the whole of one side, and this must be cut away before the mat can be used. At the top of the same picture that job is shown partly done. A sharp chisel or sharp wet knife is the best tool to use for this. Of course, the manufacturer could himself do this job but the mat would then cost you more than the dollar it does cost, hence you get the mat plus some exercise, and no extra charge for the latter.

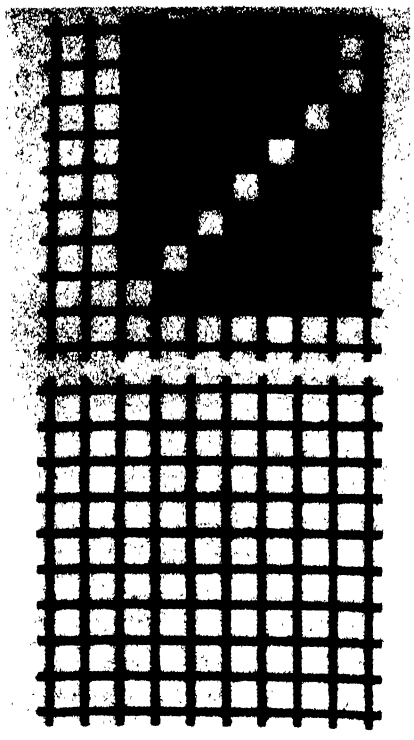
To use the door mat, according to Everest, you place the tool, face up, on a table and tie a string loosely around it, or snap on a rubber band or two. Then you lay the mat on top—all as shown in Figure 1.

Next insert cardboard strips around the edge, for dams (Figure 2). Everest says that pitch applied in such small amounts as one facet at a time (as you will see later) has no tendency to creep under the rubber or through little openings around these dams. He also writes: "We make our laps on a clean white table cloth, as shown in the photos." However, if your wife hasn't the fine disposition his has, we advise the addition of a bed pad.

Now (Figure 3) pour melted pitch into each of the square openings, using a spoon. This same photograph shows—at least the original does—the famous unruly Everest hair which Porter immortalized in a sketch in A.T.M. It seems that when Wallie was rounding a shoulder of Pike's Peak, on his way to California in '49, a big grizzly bear suddenly reared up near him and his hair instantly reared up too. Since then he never could make it lie down or do a thing with it.

Figure 4 shows the squares full of pitch. Of course it will occur to anyone to pour them all to about the same depth. Now chill the lap under a cold water tap and (Figures 5 and 6) peel off the door mat. It won't stick, and when it is first put on it needs no goose-grease to keep it from sticking.

Now soften the lap under the hot water tap and press it to contact with your mir-



The Door Mat. *Top:* Partly cut out. *Bottom:* Ready for business

tor. Then trim off the little irregularities caused by pressing—a simple matter, as Wallie says, like the small trimming you have always done on laps in order to keep the channel open during a polishing job.

Figure 7 is the finished job—hold up the page and squint your eye along both sets of channels. Isn't it a dandy? Here is what Dr. S. H. Sheib of Richmond, Va., who borrowed your scribe's door mat, has to say:

"Dear Doc: I have tried out the door mat you lent me and find that it does everything that is claimed for it. These gentlemen deserve the gratitude of all telescope nuts for relieving them of the abominable and profane job of channeling pitch. Removal of the web is easily effected, as you have suggested, with a sharp 1" chisel, but may be done equally well, though more slowly, with a sharp wet pocket knife.

"In making the lap one must remember, of course, to smear the top of the tool with turpentine, and to place the center of the tool at the corner of one of the facet squares, in the regular manner. This done, it is difficult to imagine how even the most inexperienced worker can fail to make a perfect lap every time. There is no need for rush or hurry—if interrupted at any stage, the work may be set aside and resumed at any later time without risk of injury to the lap. The V-shaped ribs of the grid show no disposition to cling to the pitch, provided the whole is well cooled after the squares are filled, but part readily, leaving beautifully straight, clean, smooth channels without a trace of pitch on the bottoms."

In the final photograph of the series you see Wallie testing by finger nail for hardness on his pet scale, which you will find added to page 364 in the new edition of A. T. M.

We asked Everest whose baby this new thing is and he says that the "only" thing he can take credit for is the idea. He says Ralph Munn then made the mold and the pre-

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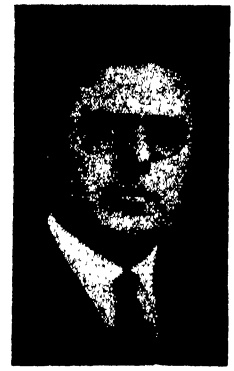

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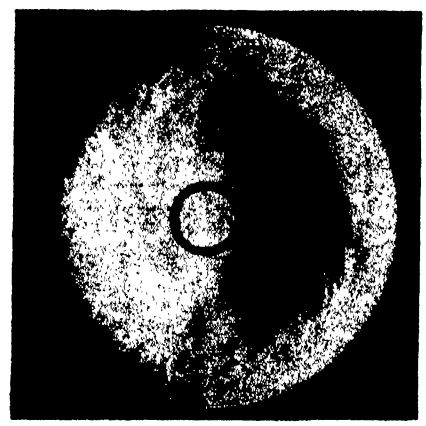
liminary samples, but had a little trouble getting perfect door mats, and so he accepted the offer of H. F. Morse to complete the development at Bridgeport, Conn., where they have had more experience with such things, and Morse was assisted by G. Carlson, also of Bridgeport. Morse then "made arrangements," Everest says, "with a manufacturer to supply door mats at a dollar each to any of the maniacs who desire them."

A lot of the above must sound much like a sales talk but, if so, it can't be helped, and no apology is offered to the cock-eyed world for it. The four who got up the door mat aren't making anything from it, and their only idea was to find a rubber goods manufacturer who would undertake to bother with it. They found that door mats could be made and sold, non-profit, for about 75 cents plus postage. Blame your scribe for suggesting that the price therefore be set at an even dollar, postage free anywhere within the confines of the planet. It is true, this penalizes the nearby purchaser for the benefit of the distant one, but it saves a lot of preliminary bother about ascertaining mailing costs to all sorts of out-of-the-way places and the "injustice" probably will not seriously affect anyone.

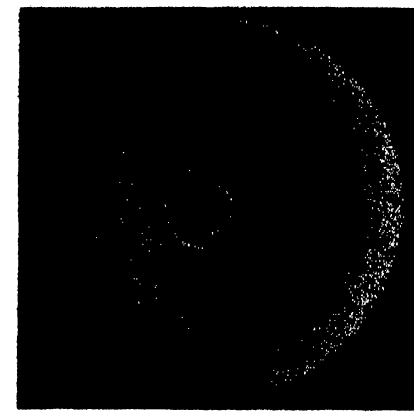


The mangled mirror

As there still seems to be some uncertainty about the degree of refinement required of a good optical surface, three recent illustrative focograms are reproduced on this page. The job shown above was ground and polished by an amateur, as the Pyrex, perforated primary mirror for a 12½" Gregorian. The mirror is approximately an *f*/5. The owner says he sent his mirror to a man who offered to refigure mirrors and that, when he sent it, there were no scratches on it. A fee of 25 dollars had been quoted for its correction, he says, "up to any measurable error." This focogram represents the mirror when he got it back. Not only is the surface deeply scratched and scored in many places, but it is very lumpy in the small areas not scratched. Study the reproduction closely. The Ronchi bands also were zigzag, the owner writes, "like a snake."

Of course 25 dollars was too little, in the first place, to charge for refiguring a 12½" mirror—far too little. Men like Pierce or Tinsley or Lower would probably ask much more, and rightly so. But a promise that can't reasonably be kept should perhaps not be too freely made, in the first place.

The figurer, when the matter was sub-

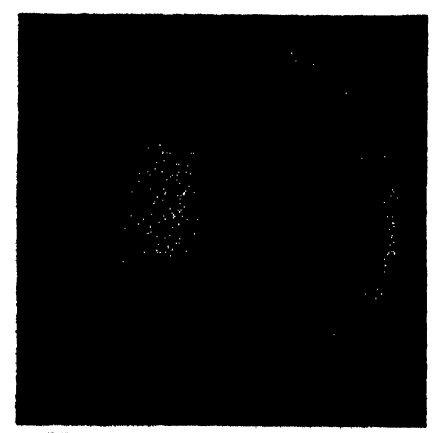


Same mirror—owner's own job

mitted to him by Scientific American, after the owner had failed to get results, offered to refigure this mirror. But in the meantime the owner had decided to try it himself, and he was able, to his own surprise, to produce the result shown at the top. We leave it to the reader to judge which is the better of the two.

The job at the bottom of this column is the 8" primary for an *f*/5 aplanat, and was entirely made by Mary A. (Mrs. A. W.) Everest, 15 Allengate Ave., Pittsfield, Mass., with the moral and intellectual support of her husband, Wallie Everest. She made free use of his advice, but slapped his hands whenever he tried to touch the mirror, and he is considerably prouder of it than she is. Three ¼" scratches and one ¾" scratch show on the original focogram, but they are so fine and thin that they did not pick up in the half tone. The little nick at the bottom is the shadow of a part of the test rack. On the other hand, about 80 percent of the faults of the other (at left) focogram do show—they are so gross that a half tone could not help picking them up. There are no lumps and bumps on the Mary Everest mirror—the surface is an *optical surface* with smooth texture. (We gave such surfaces a name, a year or so ago, but it isn't decorous!) The high lights blend into the shadows in a gradual, even transition. The edge is not turned—note the left hand diffraction ring, as per A.T.M., 371. The "crest of the doughnut" (A.T.M., 262) is in the right place, seven tenths of the distance from center to edge. This mirror would rate as high grade workmanship in any kind of society.

Perhaps no one should set up as a professional, paid refigurer of mirrors "up to any measurable error" who cannot do high grade work; and perhaps, if work really is



Mary A. Everest's workmanship

to be turned out on a buzz saw, at a quoted price which makes high grade work impossible, that fact ought in fairness to the inexperienced seeker of help to be frankly stated beforehand. These comments will also serve, it is hoped, to warn the inexperienced—just the ones who are least likely to sense the same fact—that they should not reasonably expect a high grade refiguring job on a 12½" mirror for 25 dollars, since refiguring a mirror is almost as big a job in some cases as making a new mirror. On the other hand, a pit or two, or a light scratch or two, is not as important a thing to notice as the surface texture ("schoolmarm's leg," if smooth) and the edge—these are the two most important things. By the way, look in vain for the left hand diffraction ring on the middle focogram - or the upper one, for that matter.

We have purposely given no names or identifications in the above, as the motive for publishing these blunt comments is not to hurt anyone but to warn the inexperienced about the fallacy of low-priced services in optics, and perhaps to help keep the general standard of workmanship at a good level.

PROF. C. C. Wylie, astronomer at Iowa State University, Iowa City, Ia., and President of the Midwest Meteor Society, writes that he has been sending observers above the clouds in airplanes to count meteors. "If any of your amateur astronomers have airplanes and would be interested, I will be glad," he adds, "to correspond with them." Here is a chance to die as a true martyr to science—not tamely in bed.

William Tyler Olcott, 62 Church St., Norwich, Conn., author of numerous books on amateur astronomy and one of the founders of the American Association of Variable Star Observers, asks us to announce that any person with a telescope of 3" aperture or larger can engage in the work of the Association, which has a membership of 330. This organization is mainly amateur and its meetings bring together amateurs from many states. No one should feel backward about applying for membership. Another chance to be a (live) martyr.

THE new edition of A.T.M., described elsewhere, contains a chapter emphasizing rigidity in mountings, explaining the principles of getting it, and showing how to make three massive new mountings of solid concrete which Porter, the author, labels "Porter's Follies;" also 16 fine new drawings by Porter. Everest's new chapter on HCF is not a revision but an entirely new story, describing his successful technique. Pierce has a brand new chapter on clock drives. The quoted matter on pages 234-240 has been replaced by a full, illustrated treatise on close machine figuring, by Hindle, and the matter on pages 337-343 of the previous edition is replaced by a valuable treatise on the calculation of sidereal time, by the Mayalls of sun-dial fame. About a dozen new notes appear in the Miscellany, also several dozen minor corrections there and elsewhere, and at the end of the book your scribe adds three pages entitled "A Last Word to the Beginner" and winds up with his own immodest picture. This is in answer to numerous requests, but of course nobody will believe this, so go ahead—all you fellers—and tell him he is no shrinking violet and ought to be ashamed of himself!

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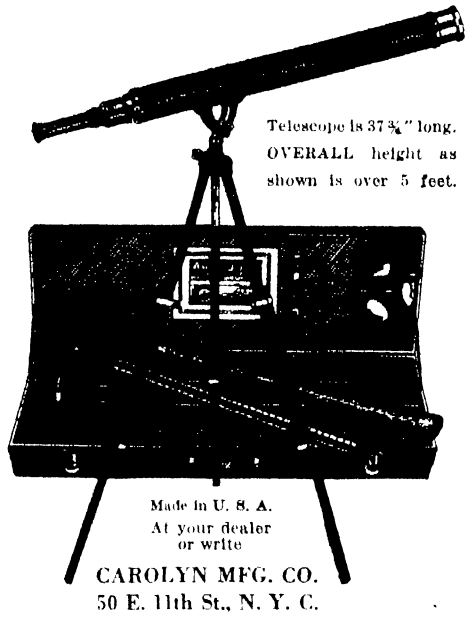

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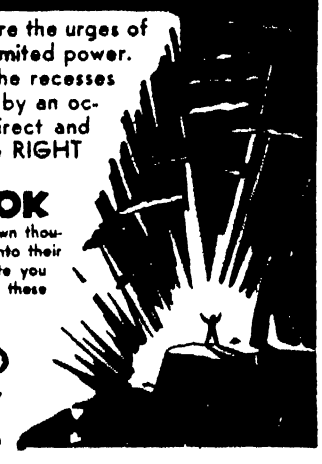

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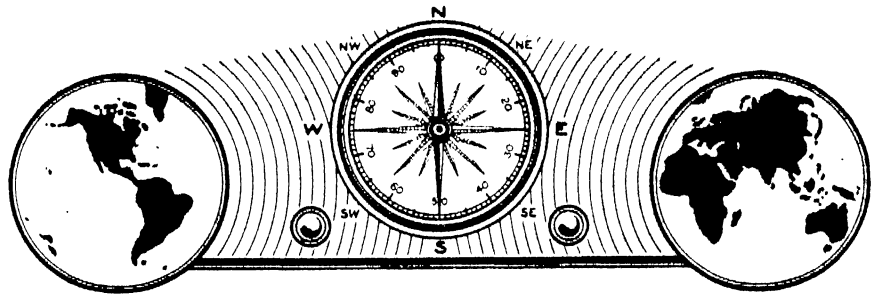


WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN

A Drama in Radio Science

THE true follower of science is sure to be interested in the manner in which man obviates nature's obstacles. That some of man's methods are ingenious is to be expected, but they are not always dramatic as well. The all-wave listener who is fortunate enough to pick up the unexpected call, the snatch of conversation between shore and ship, or the impromptu chatter of a standby operator, is amply repaid for the time he has consumed searching the bands—but the man who is witness to the dramatic use of an experimental radio system is doubly repaid for his patience.

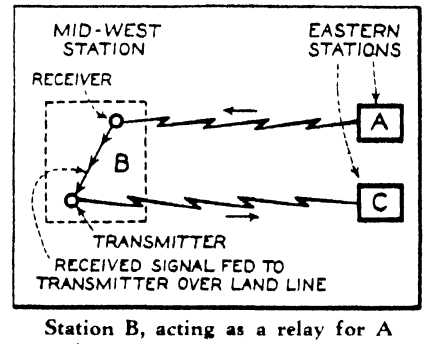
One of the oddities of short-wave transmission and reception is the effect known as "skip-distance." Because of this effect, an amateur, for instance, may be able to carry on an unbroken communication with another amateur a thousand or more miles away, but find himself unable to receive the signal from an amateur transmitter 10 or 15 miles distant.

The situation is odd to say the least, for the signal from a nearby station becomes a "catch," whereas the signal from a distant station is received like a "local." Moreover, interference with communication comes not from transmitters in one's vicinity, but from transmitters 500 miles or more distant. This effect is particularly noticeable in the 20-meter amateur 'phone band and, as might be expected, this prank of nature has been put to good use in many instances; a use, incidentally, that lends much interest to the listener as well as the amateur.

Now, observe the amateur who wishes to operate "duplex"; that is, to arrange his equipment so that he may receive signals during periods of transmission. Under ordinary circumstances, this is quite impossible for, when the transmitter is in operation it blocks the receiver and no signals may be intercepted. However, if the transmitter is removed a sufficient distance from the receiver, and remotely controlled, then it is possible to receive signals while the transmitter is in operation, with the advantage that the other fellow can "break in" on the transmission at any time to ask for a repeat, to laugh, or say what he pleases as thoughts come to his mind, just as two people are able to converse on the telephone. The system, of course, is effective only in the event that both amateurs are able to receive as they are transmitting.

Some amateurs have their transmitters as much as a mile distant from the receiving point. The result is that the ground wave from the transmitter is too weak to cause much interference with reception, while the sky wave is "out of reach" of the receiving aerial. In other words, the amateur places his receiver in a location comparatively free from the signals radiated from his own transmitter. Under these conditions, he may be able to tune in other signals having frequencies only a few kilocycles removed from the frequency of his own transmitter.

And so it is that occasionally, when one least expects it, some amateur station equipped for duplex operation will pull a stunt that adds a bit of drama to the science of radio. Thus, quite recently an amateur



Station B, acting as a relay for A and C, overcomes the skip-distance

on the east coast was anxious to communicate with another amateur just far enough away to make a telephone call an item of expense, but also just near enough that it was quite impossible to make satisfactory radio contact, because of the skip-distance effect. An amateur in the middle west came to the rescue by functioning as a relay station. Since he was equipped for duplex operation, he could receive while transmitting, so he picked up in turn the signals from the eastern stations and "re-broadcast" them, with the result that the east-coast amateurs, situated probably no more than 15 miles apart, carried on a conversation by proxy. The accompanying sketch illustrates the manner in which the three-way contact was conducted.

This sort of stunt is by no means new, nor is it a rarity. The listener is often fooled, however, unless he happens to hang on long enough to realize that there is an intermediary.

Amateurs also go in for "cross-channel" operation, and this is also apt to be misleading unless the listener waits for station calls and gets the hang of what is going on.

In cross-channel operation, one amateur may be set up for transmitting on 20 meters

and another amateur set up for transmission on 75 meters (80-meter band). Therefore, amateur number one tunes his receiver to the 75-meter signal and amateur number two tunes his receiver to the 20-meter signal. From then on, two-way communication may be carried on.

Obviously such a tie-up must be pre-arranged. Consequently, if an amateur working on 20 meters wishes to contact an amateur working (and listening) only in the 75-meter band, he may telephone some other local amateur who operates on 75 meters and ask to have his signals picked up and re-transmitted on 75 meters, in which event he can call the other amateur and maintain contact in this manner, or request the other fellow to listen for his signals on 20 meters, at which time the relay operation can be terminated.

You are apt to run into most anything in the amateur 'phone bands. Since these stations are in operation principally for experimental reasons, it is not unusual if one hears curious transmissions.

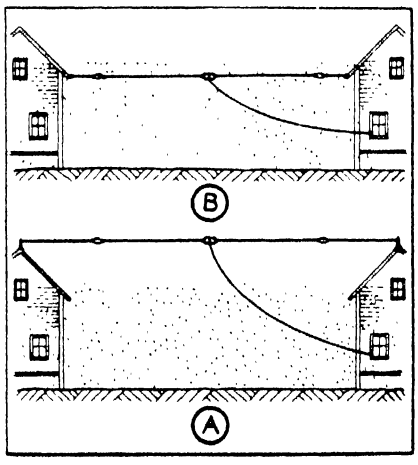
Two-Way Reception

THE listener who enjoys the conversations to be heard in the amateur radiophone and ship-to-shore radiotelephone wavebands can gain a point by using two short-wave receivers, one for each end of the communication link. It is preferable to use a separate antenna for each receiver.

Auto Ignition Systems

THE question is often brought up as to why the interference from the ignition system of an auto should be so pronounced when the all-wave receiver is operated in conjunction with a noise-reducing antenna system.

The answer is that most auto ignition systems are husky transmitters and radiate



All-wave aerial is above noise area at (A), and in noise area at (B)

high-frequency impulses over a considerable area. If these impulses reach the aerial wires proper—which they do in most instances—the "noise-reducing" feature of the antenna system is of no effect.

The accompanying sketch will serve to explain why this is so—and also why *any type* of noise-reducing antenna system is practically worthless unless the horizontal wires are erected above or outside the noise area.

The sketch shows that man-made static is inclined to hug the ground. Therefore, if the aerial proper is placed high enough, it may be kept out of the general noise area. The fact that the lead-in from the aerial passes through the noise area is of no consequence; it is so made that the interference it collects is balanced out at the input to the radio receiver.

The higher the aerial from earth, the less interference from auto ignition systems and other electrical equipment. However, since ignition interference is particularly pernicious, considerable improvement may be had by running the aerial at right angles to the road upon which motor traffic is heaviest.

Use of Tone Control

EVERY modern all-wave receiver is equipped with some form of tone control. This device is included to permit the listener a bit of latitude in tone shading.

Since the average tone control decreases the amount of high audio-frequency amplification when turned to the left, it may be used to advantage as a noise and interference reducer in the short-wave bands.

Most background noise, and certain forms of station interference, are at the higher end of the audible band of sounds. Consequently the tone control is effective in reducing these forms of interference with reception.

Indoor Aerials

AN indoor aerial is seldom satisfactory for reception on any wavelength. When used for short-wave reception, it is apt to pick up more noise than signal. When used for standard broadcast band reception, the signal being received may suddenly become weak, and after a period of time just as suddenly become strong. If the receiver is equipped with automatic volume control, the only noticeable effect may be a sudden increase in the intensity of background noise.

This change is often presumed to be a fault in the receiver. More than likely it is due to nothing more than the closing of an electric-light circuit paralleling the aerial wire. The light circuit forms a tuned or resonant circuit, and functions as an absorption loop. It practically drags the signal voltage right out of the aerial, with the result that the signal intensity suddenly decreases when a light is turned on. The shorter the indoor aerial, the more pronounced the effect. Quite often the effect is noted on the signals from one station only. In this event, the light line is resonating at the same frequency or wavelength as that upon which the station operates.

Verifications

THE fact that you may hear, say, Vienna on the short waves is fact enough in one sense, but possibly pure fancy in another sense. You have heard no station *directly* until you have been able to establish the fact by *final* announcements. There is a great deal of rebroadcasting going on, and the confusing part of it is that many of our own short-wave stations enter into the scheme. The next time you hear a foreigner, make sure first that the signal is not being picked up and redistributed by W2XAF or some other local short-waver, before you spread the news around.

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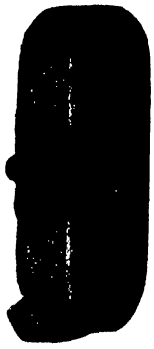

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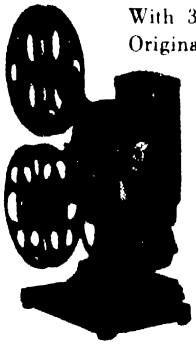

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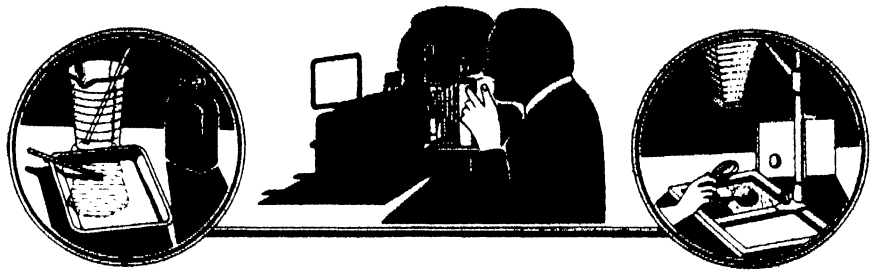


CAMERA ANGLES

Conducted by JACOB DESCHIN

Series Photography

ONE proud father has taken a picture of his baby every month for two and a half years and has noted a change in each one of them. That's a series that will give him and the child's mother pleasure all their lives and will hold intense interest for the child herself when she grows up. Many proud fathers have taken pictures of the youngsters and the number of these pictures taken annually would, if placed end to end . . . But the point is that unless there is a conscious and conscientious effort such as that put forth by the proud father aforementioned, there is a lack of the atmosphere of progression and therefore no series, the field of photography which we intend to advocate here.

A series of photographs should comprise a succession of prints from the beginning onward, showing significant changes, distinctive developments. It may tell a story, describe an incident, constitute a history. In any event, the pictures are related, connected, bound together in progressive fashion by a central idea or interest chronologically expressed in pictures.

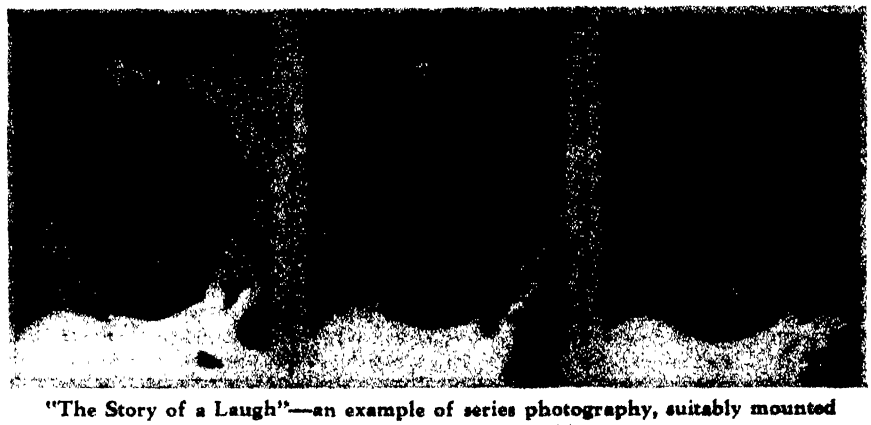
Aside from the series of pictures showing definite changes in the baby or child at successive stages in its life, there is the type of series which illustrates the flowering of an emotion, such as that illustrated in "The Story of a Laugh." These are not easy to accomplish and may often be the result of happy accident, but, however achieved, their value and interest are obvious.

Step-by-step pictures of the building of one's home or the rise of some notable building, bridge, or other structure in the town are types of series which may be photographed from sentimental or historical motives, or both. Watching for good lighting conditions, stopping down the lens for all-over sharpness, careful choice of significant points of view—these are some of the points to be considered if such series are to be worth while.

The play or game, the picnic or house party may "go home" with you if you have your camera along and use it judiciously. The play will require the modern fast lenses and the game a telephoto, though this may not always be necessary. But a fast lens is no longer a novelty and many an advanced amateur has tasted the thrills of telephotography. Plays and games will call for many shots in order to make it possible to line up a series of prints which will give the story of the occasion.

A series to illustrate an outdoor picnic or a party at some one's house is less of the forthright thing than most series are and depends greatly on the camera man's sense of selection, his feeling for humor, and the way the party is going. If the tempo is not to his liking and picture material not forthcoming, he can create picture material and everybody will be glad to help, for who doesn't revel in picnic pictures? Series at picnics and parties would probably turn out to be a number of series of various aspects of the event rather than a single series tying the whole thing together. The story of how one party learned to swim; the preparation, roasting and eating of a fowl, or what have you; the start-to-finish pictorial account of a hand-to-mouth encounter with the victuals, showing as the first picture a rich "feed" spread out on the cloth, and as the last, a cloth covered with empty bottles, empty cans, and the riotous disorder denoting full stomachs—these are all good subjects. If you go picture-bent to a house party be sure you are well loaded with Photoflood bulbs and flash bulbs; you will never regret it and will be the most popular person of the occasion.

Other types of series might be mentioned, but these few should suggest the possibilities of the idea and how it may be used to suit

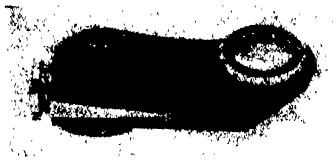


"The Story of a Laugh"—an example of series photography, suitably mounted

individual circumstances. To get the most out of your series, be sure to mount them in such a manner that every picture in a series is placed in its proper order and the whole kept together in an album, mounted one after another on a long strip of cloth or heavy paper which can be folded accordion-fashion, or joined together in some other way. For series of pictures not exceeding a half dozen it might sometimes be desirable, if the photographs are compelling enough in interest and are good technically, to arrange them inside a frame to be hung in some appropriate corner.

New Range Finder

GUESS-WORK in focusing is eliminated for camera workers equipped with the new Kodak Pocket Range Finder. Designed with a clip, it may be carried in the pocket like a pencil. Reasonably priced, convenient and simple to use, it makes an exceedingly useful adjunct to owners of focusing cameras who have to estimate distances by the eye or pacing off in order to get the subject sharply focused. While such methods have been and still are adequate for most purposes and under generous lighting conditions and closed-down, depth-producing lens apertures, yet for critical focusing, particularly when using fast lenses at wide apertures, a range finder such as this one is essential. Only cameras equipped for ground glass focusing will give the same sharp results. An ingenious feature of the new instrument is that the correct distance is seen on a translucent scale at the same time one is viewing the subject. Focus is accomplished by turning a knob until the upper and lower portion of a subject, cleft in twain by a bar, coincide. In the opinion of the writer, the dividing bar is too wide for critical matching of the two parts, but practice in the use of the instrument may enable the operator to overlook this.



Compact range finder

Contaflex

USING the Contax camera as a basis and substituting the reflecting mirror type of focusing for the range finder, the Zeiss Ikon organization has turned out the Contaflex. While employing several original improvements, the Contaflex is fashioned on the style of the miniature reflex cameras employing two lenses, one for taking the picture, the other for focusing. With the exception of the range finder, all the Contax features, already familiar to miniature fans, are retained.

The most distinctive and original feature of the new precision outfit is the focusing arrangement. Instead of having a focusing lens of larger aperture than the taking lens, the Contaflex differentiates between the two by employing a focusing lens of 8-cm focal length, while retaining the standard or 5-cm lens for making the exposure. This gives a larger image on the ground glass than the film image, facility in focusing being assisted by a plano-convex lens ground glass, the flat surface being matte. The advantage of this lies in the fact that the light gathered into the focusing lens is concentrated and not diffused, as in the case of the ordinary ground glass.

The front part of the ground glass hood is an albada finder, the semi-silvered mirror of which permits self-portraiture by "composing" one's self in the mirror and also may be used as an eye-level finder for photographing objects in rapid motion.

A built-in electric exposure meter, the prisms of which are exposed to light by lifting the name plate on the front of the camera and thus permitting light to penetrate to the photoelectric cell behind them, stands next to the Contaflex focusing arrangement as the second ingenious departure in construction contained in the camera. It may be manipulated so that it serves even for very weak light conditions. Readings are obtained very quickly from 1/1000th of a second to 160 seconds, an exposure range of 160,000 steps.

Packaged Chemicals

THE package influence has almost wholeheartedly won the art of photography for its own. The darkroom routine of weighing out specified quantities of various chemical ingredients of a developing or other solution is fast fading out of the picture as prepared quantities, conveniently packaged in a box, or ready-mixed solutions in bottles are being put on the market and gratefully welcomed by darkroom workers. Even acid hypo may be had in a concentrated form so that all one need do is pour out one part of this solution to so many parts of water. Thus, good old hypo, which to many is a rather messy job of work to prepare, becomes an arm-chair procedure.

This simplicity obtains also in the cases of various film and paper developers, packages or bottles being available to fill almost any need in these lines. Solutions or packaged chemicals ready weighed out are also obtainable for most other darkroom purposes.

All this does not, however, mean that we may forthwith discard the studio scale and discontinue the purchase of individual chemicals, for there will be special occasions when we shall want to try a little experimenting.

Screw Adapter

AN amateur who recently found himself in a dilemma when he discovered that the screw base on the bottom of his camera was of the metric (European) type, almost despaired that he would ever be able to mount it on an American tripod. But the day was saved when he learned that there are such things as screw adapters threaded on the outside to fit into the base and on the inside to take the American-type screw of the tripod. It is a simple operation to screw in the adapter, and the cost is only a dime.

Try "Shooting" Feet

THERE'S more to the human anatomy than the face and while the latter is admittedly the most interesting feature, much can be said of the photographic possibilities of the pedal extremities. Feet can be made a fine subject for the camera pro-

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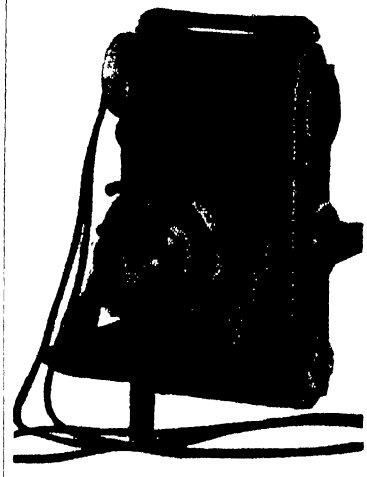

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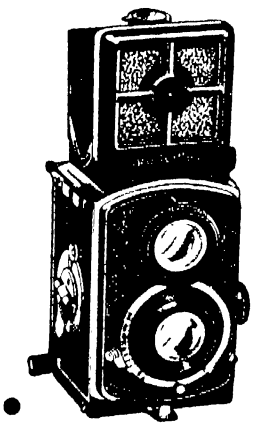

The uniquely different construction of these cameras facilitates the making of better photographs. They possess two lenses—one which takes the picture—the other which focuses your scene or subject in actual film size on a luminous ground glass finder. These lenses are synchronized so that your "preview" in the focusing hood and your finished photograph are identical. These cameras possess, moreover, a number of automatic features found in no other instrument and represent an ultimate present-day perfection in the construction of precise, picture-making instruments.

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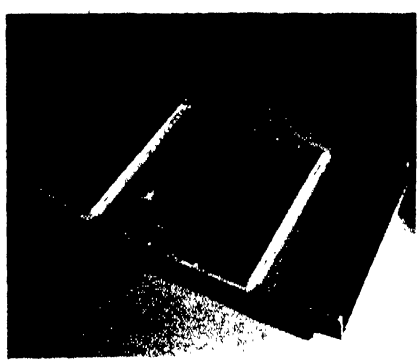
vided a little imagination is used before one attempts clicking the shutter promiscuously. A subject such as this has to be thought out in advance, and a series might take several months to complete for worth-while opportunities may not present themselves as quickly as one might like. Possibilities in this direction might include the feet of a dancing Negro boy, a child's feet peeping out of the sand on the beach, a laborer's feet treading the earth, the feet of a pair of dancers on a dance floor. The list is a long one. Try making one up and then hunt for the subjects.

Home-Made Film File

THE filing of roll-film in the miniature sizes seems to present a problem to the amateur, judging from the great number of suggestions that one hears. Excellent varieties of files for these films are obtainable at varying prices, and most of them are very efficient files, too. Many amateurs, however, prefer to make their own. The idea presented here is offered in the hope that it may suggest a system for some workers who are still grappling with the problem and are looking for help.

An unused silverware box was about to be discarded when the family photographic



A home-made film file for 35-millimeter rolls, designed so that the film may be kept in rolls, yet any individual negative found readily. Any box of suitable size and with a lid may be used. Divisions for keeping rolls in place are formed by crossing lengths of thin copper wire

addict came along. He saw its possibilities, and the result appears in the accompanying illustration. Velvet "upholstery," pieces of wood, nails, the clasp on top, and so on, were ripped out mercilessly, and the box then lined with black paper. A strip of cardboard was glued on to one half of the cover so that the cardboard jutted out about ¾ths of an inch. This was done in order to keep the dust out when the box was closed. Squares were ruled off, eye screws inserted about 1¼ inches apart, and thin copper wiring strung criss-cross, allowing for 48 spaces to accommodate a roll in each space. The spaces were numbered, 1 to 6, 7 to 12, and so on, and a card index used to record the contents of each roll. Now it is a simple matter to hunt through the index for the subject desired and then to pick out the roll containing it.

This system not only saves wear and tear on films, which produces those dreaded scratches, but saves time, temper, and travail. Any similar box may be used, of course.

BUILD A PHOTOGRAPHIC LIBRARY

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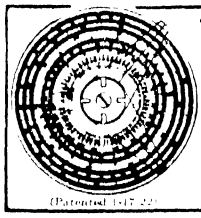

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THE SCIENTIFIC AMERICAN DIGEST

(Continued from page 38)

before and never published since 1890, when they came into my care. I bought them in 1918, when the company dissolved.

"A four-hour fight (during the American Civil War) gave the control of the sea to the North on March 9, 1862, without the loss of a single man. It took General Grant four years to win on land.

"The importance of the control of the sea was illustrated in the late war. If Germany had had a John Ericsson in 1915, who had held back America and her war supplies, as well as the *Monitor* held back England and France and their war supplies, in 1862, she would have won the war."

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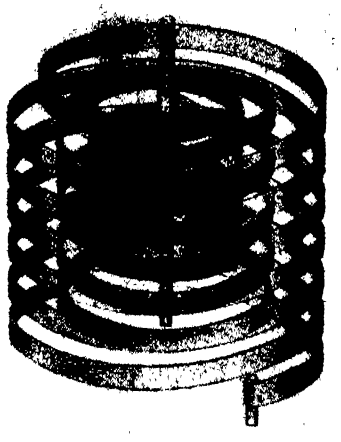
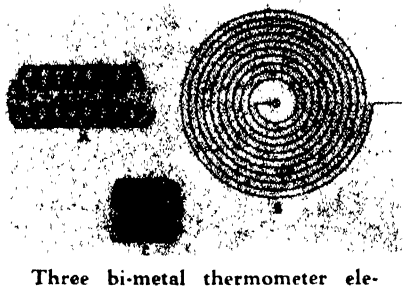


Enlarged view of one of the bi-metal thermometer coils



Three bi-metal thermometer elements to provide same deflection. Coils A and C, 0.32 inch diameter

control devices has recently been developed in Europe and will soon be introduced into this country. Making use of bi-metal strip which deflects in proportion to temperature change, the principle involves a unique method of winding the strip into a unit of concentric helical coils, so that the forces of deflection are additive, but the forces tending to cause distortion and friction are mutually counterbalanced within the coils.

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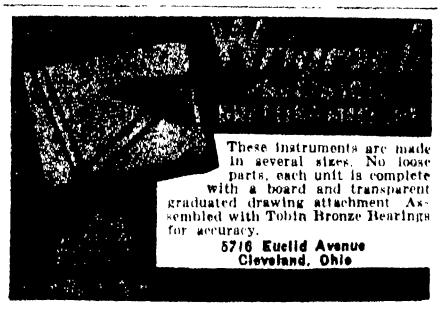

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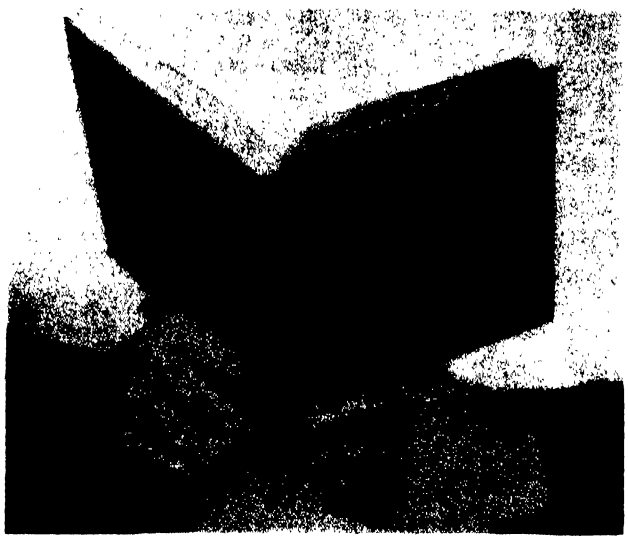

THE SCIENTIFIC AMERICAN ANNUALOG for 1936 is the 11th volume of a series, each complete in itself, that gives a complete picture of the progress of science during the year. It covers in a comprehensive and interesting manner all of the important sciences, particularly as they apply to various industries. The scope of the book is such that it gives a world of worthwhile information to the reader who is endeavoring to keep abreast of progress. Whether you read it for pleasure or profit, you will be well repaid. Thoroughly illustrated. 216 pages, board covers.

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to or exceeding that of the ordinary spirit of mercury type, according to tests made in the laboratories of the German College of Science and Technology, Prague. Tiny thermal elements less than ¼ of an inch in length, or large elements with sufficient torque to move a pointer six or more feet in length can be constructed with the same general form of coil. Deflection sufficient to space out a narrow temperature range over a 360-degree circular scale is said to be obtained without loss of accuracy.

A coil consisting of concentric helices—in reality, "coils within coils" in which all the forces except that which causes angular deflection are mutally counterbalanced—was found to offer a mathematically balanced unit which was both rigid and compact. In most applications, the unit requires no supporting bearing at the working end. Even when a bearing is desirable, there is no tendency for a shift in the axis of rotation, which ordinarily leads to varying frictional resistance at this point.

Perfected coil-winding machines are now being installed in America at the plant of the Weston Electrical Instrument Corporation. Studies to provide a background for using the principle in instruments specifically designed to meet American requirements are now being carried on by that organization.

SUGAR WINDOWS

SLAPSTICK comedies are few and far between these days but even so a movie villain is now and then tossed through a window. When you see this, don't cringe for fear the glass will cut the actor for the property man has prepared this glass-like pane from sugar.

EXCESS VITAMIN D IS HARMLESS

TAKING large amounts of rickets-preventing vitamin D into the body causes no harm whatever, it is indicated in recent research by Dr. Harry Steenbock, the Wisconsin University scientist whose research has led to irradiation of food products to increase their vitamin-D content.

With irradiation of food products becoming increasingly popular, there is a possibility that many persons consume vitamin D in excess of their needs. Since this vitamin increases the power of the body to fix calcium, it has been a matter of considerable speculation whether this element may be fixed in injurious amounts, or whether the vitamin D may have other undesirable effects.

Dr. Steenbock conducted feeding trials with experimental animals over a 10-month period, allowing them to consume vitamin D in far greater amounts than human beings are ever likely to. While commercial irradiated milk usually contains about 50 Steenbock units of the vitamin per quart, the Wisconsin investigator used milks varying in potency from this figure up to 5000 units per quart.

All the common methods of fortifying milk with additional vitamin D were employed. Some of the milks were laboratory

irradiated, others were produced by cows fed irradiated yeast, and still others were supplemented with irradiated ergosterol and cod-liver oil concentrate.

The experimental animals were given no other food than vitamin D milk to which small amounts of iron, copper, and manganese were added. They were given all they could drink during the 10-month period.

All the animals grew well, were uniform in appearance, and showed no evidence of abnormality whatever.—*Science Service.*

Oilless Compressor

A NEW air compressor requiring no lubrication in the cylinder has been developed by the use of graphitic carbon supporting rings and segmental pressure rings also made of carbon. Metallic friction in the cylinder is thus eliminated.

This design insures against contamination of the air or gas by lubricants during compression. This construction is possible because of the self-lubricating qualities of the carbon rings. The pressure rings are expanded by metallic inner rings so as to give the proper wall pressure.—*A. E. B.*

Modern Treatment for Burns

WARNING against old-fashioned home remedies for burns, such as smearing the burn with butter, grease, ointment, oils, or even that old stand-by, Carron oil, was issued by Dr. A. B. Bettman of the University of Oregon Medical School at the recent meeting of the American College of Surgeons.

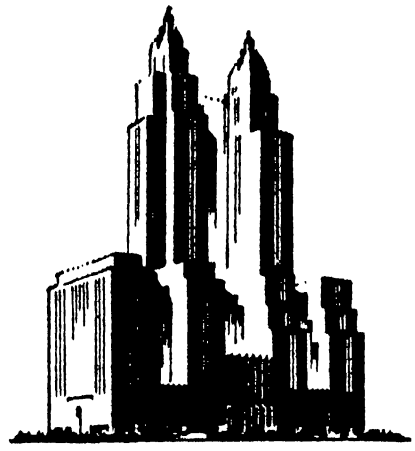
"At the present time," he said, "physicians have learned that the best treatment for a serious burn is to give the patient a narcotic, remove the burned tissue, and apply, first a 5 percent solution of tannic acid, and then, immediately, a 10 percent solution of silver nitrate. This forms, almost instantly, a black, leather-like, antiseptic, protective dressing. This is dried quickly and kept dry. No other dressing is applied."

After the actual burns are dressed there must be a comprehensive program of treatment for the patient.

As to first-aid measures in case of burns Dr. Bettman advised the following: "The best and safest procedure in extensive burns is to call a physician immediately, in the meantime keeping the patient warm, and, if no tannic acid solution is available, to make frequent applications of strong tea, freshly brewed with from eight to ten heaping teaspoonfuls of tea leaves to a pint of water. Non-greasy, tannic acid pastes are also of value."—*Science Service.*

Self-Vulcanizing Rubber

"SELF-VULC" is the name of a pair of self-vulcanizing rubber compounds recently introduced. One of these compounds is a liquid and the other is a plastic material; both are used for producing rubber linings and coatings in equipment. Whichever compound is used, it is first necessary to coat the surface with one coat of a priming compound. The liquid rubber compound may then be applied to the surface in any feasible manner such as brushing, spraying, or dipping, after which it vulcanizes itself when exposed to the air. The plastic com-



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pound is applied over the priming by means of a spatula or other flat tool and similarly vulcanizes itself cold.

These products are recommended by the manufacturers for protection of both inside and outside surfaces against abrasion, penetration of liquids or gases, and corrosion. —*A. E. B.*

Honey

HONEY as a dressing for wounds was popular at one time in the Middle Ages. Still earlier, during the Roman Empire, it enjoyed a certain vogue; and Pliny refers in a certain passage to fish fat and honey as making a good ointment for wounds. It may well be that the fish fat he refers to was cod-liver oil.

Honey has been re-discovered as a remarkably effective ointment. In a Red Cross hospital in Hamburg, Germany, tests have been carried out with honey during the past half year, and it has been found that even much soiled wounds quickly become cleaner under its influence. But though it cleans a wound, it does not seem to make it heal more quickly than before. As cod-liver oil promotes rapid healing, it has been combined wtih honey in an ointment so as to achieve the double purpose of cleansing and healing.

So in this respect we are back again in the days of Pliny, after many a digression and much circumspection.

How does honey act? Does it cause beneficial fermentation? And which of its many component parts is most potent: its sugar, mineral salts, plant acids, higher alcohols or some ferment? Doubtless the Germans, with their methodical instincts, will isolate each of the component elements of honey, and will try each in turn on a number of cases of varicose ulcers, wounds, and so on. Pending conclusive findings from these future experiments, tests with whole honey will be continued.—*Science Service.*

Roads of Salt

COMMON salt would seem to have little to recommend it as a material for road building, yet experimental highways in New York state survived the recent devastating floods in that area without appreciable effect. The roadways are sponsored by the International Salt Company, and are constructed of clay and gravel treated with a compound made of ordinary rock salt, under a method discovered by Dr. Cloyd D. Looker, research director of the company, and developed in conjunction with Dr. H. Ries, professor of geology, Cornell University.

About 100 miles of these salt highways have been laid down by the producers of rock salt, in various parts of the country, including New York, Michigan, Vermont, Maryland, Indiana, Louisiana, Mississippi, Ohio, Kansas, and Pennsylvania. After several months' use, and carrying heavy traffic, they have proved satisfactory. The rock salt, according to Dr. Looker, not only compacts the clay but also crystallizes in the road surface and retards evaporation of moisture, thereby keeping the top weather-layer moist and firm.

Once compacting and crystallization take place, the surface sheds water, providing practically a non-skid road. The mixture is intended for secondary roads and to provide firm surfacing at small cost, as its cost per mile is about one third that of asphalt and one ninth that of the cement necessary for a concrete road.—*A. E. B.*

The Dancing Pebble

NOT infrequently, in oil-well shooting, a charge of nitroglycerin is placed 4000 to 5000 feet underground. And when a "shot" is fired at such a depth, sometimes there is no evidence of sound or shock at the surface to indicate a blast.

We are told that in some oil fields shooters occasionally resort to a simple expedient to make sure the nitroglycerin has exploded. After loading and making the necessary electrical connections, the shooter stretches over the casing head a thin sheet of paper, placing on top a small pebble.

The observable effect of the blast is either to disrupt the paper membrane or to cause the pebble to jump. This simple device is said to serve its purpose quite effectively.

Laundry Uses Aluminum Paint

THE modern laundryman is all too familiar with the tendency of moisture to collect on exposed surfaces, such as walls, ceilings, and piping. Frequently the condition is such that droplets of water form and fall on completed work, causing unsightly spots and necessitating recleaning.

Although painting of laundries has been in favor for a long time, only recently has any correlation been noted between the type of paint employed and this condensation of moisture on the surface. One interesting observation has been that dripping from aluminum painted surfaces is noticeably light.

A theory advanced for the phenomenon is that aluminum paint dries to a finish that is very slightly rougher than that of gloss paints, thereby preventing the water from running together to form large drops. Thus, though the moisture may still be present, it clings to the surface and evaporates.

CURRENT BULLETIN BRIEFS

WESTON SMOKE ALARM is a four-page circular describing the application of a photo-electric cell and alarm device to smoke stacks, to warn when smoke conditions in the stack become excessive. *Write for Bulletin 136A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

WE DRIVERS is a series of brief discussions on driving, dedicated to the safety, comfort, and pleasure of the motoring public. Facts about motor car safety are told in simple, non-technical language and are illustrated with striking drawings. *Write for Bulletin 136B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

YOU'LL SING AT YOUR WORK! is the title of a beautifully illustrated pamphlet describing the latest developments in all-

electric kitchens. Interesting comparisons are made between old and new style kitchens, particularly as to the layout of equipment. *Write for Bulletin 136C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

MELANESIANS AND AUSTRALIANS AND THE PEOPLING OF AMERICA, by Ales Hrdlicka, is a survey of theories that America was peopled from Polynesia, Melanesia, and Australia, in addition to Asia. Except for the Asiatic source the author concludes that these theories are not probable. *Smithsonian Institution, Washington, D. C.—25 cents.*

AIR CONDITIONING is an illustrated pamphlet devoted solely to air conditioning equipment for use in the home. It describes both single units for use in any room, and complete systems for permanent installation. *Write for Bulletin 136D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

9-INCH LATHE BOOKLET, while a catalog describing a new type of workshop precision lathe, contains much information regarding the operations that may be accomplished in the home workshop. The descriptions of various lathes are also well worth reading. *Write for Bulletin 136E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

FEDERAL POWER COMMISSION, INTERIM REPORT, POWER SERIES NO. 1, is the first of a series of reports on power sources and power requirements of the United States, as found by the National Power Survey. Of interest to everyone concerned with any phase of the power industry. *Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.—75 cents (coin).*

SOYBEAN UTILIZATION. A 27-page pamphlet on the uses of soybean products. *Write for Farmer's Bulletin 1617, Superintendent of Documents, Government Printing Office, Washington, D. C.—5 cents (coin).*

RECENT VIEWS ABOUT SOYA FLOUR. A small pamphlet containing information on soya flour processing, also a bibliography on soy beans. A. A. Horvath, *Agricultural Experiment Station, University of Delaware, Newark, Delaware.—3-cent stamp.*

IT PAYS TO OWN A FIREPROOF HOME describes for the layman the construction of concrete homes, from cellar to roof. It gives the reader sufficient pertinent information on which he may form his own opinions. *Write for Bulletin 136F to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

A YEARBOOK OF RAILROAD INFORMATION, 1935 Edition, is a compendium of illustrated statistics covering all phases of railroad operation such as track mileage, cars in use, revenue-tons, mail revenues, and so on. *The Committee on Public Relations of the Eastern Railroads, 143 Liberty Street, New York City.—Gratis.*

CONCRETE ASHLAR WALLS describes a type of wall which is coming into increasingly wide use for homes as well as public buildings. Beautifully illustrated with numerous photographs showing the various effects that may be obtained. *Write for Bulletin 136G to Scientific American, 24 West 40th Street, New York City. 3-cent stamp.*

DIESELS FOR BATTLESHIPS?

(Continued from page 20)

any naval vessel, where full power is required for short periods at infrequent intervals.

At 21 knots, which is materially greater than the present maximum fleet speed, the power required in the proposed installation would be 1150 brake horsepower per engine, and this could be developed with a piston speed of 1600 feet per minute and a brake-mean-effective pressure of about 100 pounds per square inch.

The engine proposed should be built on a weight of 2.0 pounds per square inch of cylinder volume, without the use of light weight materials of an expensive character. This would result in a weight per brake horsepower of 15 pounds; and there should be no difficulty whatever in keeping the total weight within the limit available which Sir George Thurston has given as 87 pounds per shaft-horsepower.

All doubt, however, as to the possibility of installing Diesel-electric machinery has been removed by the abrogation of the Washington Treaty, since it is now possible to consider the total fuel weight as a part of the design schedule. With a fuel weight at least four times the allotted weight of the propulsive machinery, a negligible decrease in the cruising radius would provide a very material increase in the weight available for the machinery.

It is not possible, at this time, to say what form of drive and what type of engine will be used when the final solution has been reached, and it is probable that the latter has not yet been designed. It *is* possible, however, to realize the great advantages of the Diesel drive by using a type of engine which is being purchased by railroad executives—whose reputation for sound conservatism is fully equal to that of naval officers—for use in a service in which the conditions are much more exacting than those in naval vessels.

Owing to the fact that the economy of the Diesel engine holds up much better, at reduced powers, than any form of steam plant, and to the fact that a materially greater maximum fuel supply can be carried, the cruising radius will be increased to more than three times that possible with steam. This great advantage—which will free a fleet from dependence on tankers and fuel bases in any probable campaign—will become available when, and only when, naval operating staffs recognize the possibilities of this form of drive and demand it.

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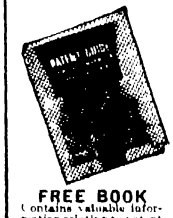

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Books SELECTED BY THE EDITORS

THE BACKGROUNDS AND FOUNDATIONS OF MODERN SCIENCE

By Richard E. Lee, A.M., M.Sc., Sc.D.

MOST modern universities nowadays wisely require all freshman students, before taking more specialized work, to attend what is called an "orientation" course in the general sciences. Such courses sweep the whole scientific horizon, covering astronomy, physics, chemistry, psychology, and the biologies, in a broad way, the purpose being not so much to teach mere facts as to provoke thought and understanding of the world in which we live. Many an adult long out of school would enjoy taking such a course, because of its broadening aspects. This can virtually be done now by reading the fascinating books of collateral reading assignments used in connection with these college courses, and this is such a book. It was written by the professor of chemistry and director of the freshman course in science at Allegheny University. Its price postpaid is $4.20.

A general reader edition of practically the same book, with the classroom exercises omitted and the text somewhat condensed, is also available under the title of "Man—The Universe Builder." This latter book is $3.20 postpaid. —*A. G. I.*

BLACKFEET INDIANS

PRIMARILY a book of full-color character portraits of individuals of the Blackfeet Indians, it also contains "Out of the North," a brief, swiftly moving historical account of them, the first authentic one ever written. The portraits—49 paintings, reproduced faithfully 7 by 10 inches and larger—were done by Winold Reiss, foremost painter of American Indians; the text is by Frank Bird Linderman. The volume is something new among books, is as native to America as the Rockies, and as colorful as an Indian sun dance. Measuring 10 by 12 inches and having a total of 72 pages, it is printed on heavy offset paper.—$3.65 postpaid.—*F. D. M.*

NEW NUMBERS

By F. Emerson Andrews

THIS book explains the duodecimal system of notation more clearly and readably than any exposition this reviewer has seen, and readers who have a turn of mind for the curious in simple mathematics should find it pleasant reading. Today we have a duodecimal (12 base) set of units—hours, degrees, inches, and so on—and we use an awkward decimal (10 base) notation in calculating with these units. We are now seeking, it is true, to change our units to metric units to make them fit our decimal notation. But because of their better divisibility, the units we already have are superior to metric units, and therefore it is our notation, not our units, which calls for change. No one in this reviewer's memory who thought long enough—three to 17 minutes—to grasp the central idea of the duodecimal system ever failed to concede its superiority. The matter of making the actual change is, of course, a separate question which does not detract from the interest in the subject. This book clearly explains the system and its uses. Persons having set, crystallized, conventional, or frozen types of minds are advised not to get it—they won't like it. Many of those who still have limber minds doubtlessly will.—$2.15 postpaid.—*A. G. I.*

OVERCOMING SLEEPLESSNESS

By Charles Wescheke, Ph. G.

THIS little book is for people who can't sleep, and is full of practical advice on how to fall asleep. It is so full of good advice about going to sleep that it kept this reviewer wide awake during the hour it took to read it. It describes many practical soporific expedients.—$1.10 postpaid.—*A. G. I.*

PHOTOGRAPHIC ENLARGING

By Franklin I. Jordan

IN a non-technical manner and as though he were talking face to face with the reader, the author of this book puts forth the fundamental principles of enlarging and of the various operations in connection with it. He offers many hints that will enable the worker to turn out better enlargements, and illustrates some of the hints with line drawings. The book is replete with samples of excellent photography, many of them from the camera of the author, and contains a Formulary and Helpful Hints Appendix that is valuable. 7½ x 10 inches, beautifully printed on coated stock.—$3.70 postpaid.—*A. P. P.*

MODERN RADIO SERVICING

By Alfred A. Ghirardi

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ly the trouble in radio receivers and also to advise correctly regarding the installation and proper usage of new receivers. The book is thoroughly up-to-date in every respect and covers the very latest information on such things as noise reducing antennas, metal tubes, interference prevention, and so on. The text is prepared so that a minimum of study is necessary in order to delve into the meat of any particular subject, and numerous drawings and photographs aid to a clear understanding.—$4.25 postpaid.—*A. P. P.*

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By Alfred A. Ghirardi and Bertram M. Freed

THIS is a supplement and answer book to Modern Radio Servicing reviewed above. It also gives in compact form useful data, tables, and formulas that the radio service man needs from time to time.—$1.65 postpaid.—*A. P. P.*

ANECDOTAL HISTORY OF THE SCIENCE OF SOUND

By Dayton C. Miller, Prof. Physics, Case School of Applied Science

THIS is a 100-page, illustrated history of acoustics up to the present century, with main emphasis on the people who have advanced the science, and much less on technical matters. The author is one of relatively few physicists who in this age of atomic physics have specialized in sound, a part of the old physics. He has known the ablest sound specialists of three generations, is himself a musician and one of these ablest specialists, and his story makes good reading. His book throws bright light into a corner of physics which historians of science have neglected.—$2.65 postpaid.—*A. G. I.*

AUTOPOWER

By S. W. Duncan

THIS little paper bound book gives direct and specific information on the conversion of certain types of automobile generators to 110 volt A. C. generators. It also includes valuable information on the testing of armatures. This is not a text book in any sense of the word but a direct and instructive "how to do it" book.—$1.00 postpaid. —*A. P. P.*

THE PHILOSOPHY AND THE CONCEPTS OF MODERN SCIENCE

By Oliver L. Reiser, Associate Professor Philosophy, University Pittsburgh

EDDINGTON, Jeans, and others having aroused popular interest in the philosophy of science, the world is being treated to a number of books which go beyond science itself (oft, perhaps, too far beyond and right out into the empyrean) and this is one of the latest of them. Since scientists are held to have too amateurish a point of view in dealing with philosophy, it remains to be seen whether philosophers are competent to deal with science, and thus reach the desired knowledge of the ultimate. This book by a philosopher discusses some of the philosophical problems brought up in the philosophy of science.—$3.65 postpaid.—*A. G. I.*

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By Eric Hodgins and F. Alexander Magoun

THERE are available many historical surveys of aviation, but all too many of them dismiss the truly historical with a chapter or two and then plunge into the developments of the last 15 years. In the present book, which is a revised edition brought up to date, fully half of the running story is devoted to the days prior to 1910. The text is rich in historical information and thoroughly illustrated with interesting old prints. The more modern part of the book is equally well written and deals briefly with record flights and commercial flying.—$2.95 postpaid.—*A. P. P.*

THE RANGE OF HUMAN CAPACITIES

By David Wechsler, Ph.D., Chief Psychologist, Bellevue Hospital

WE who have only mediocre abilities often wonder whether others who have outstanding abilities or even genius are persons like ourselves but simply better endowed, or are really another psychological species (the "divine spark" theory). The author's very scientific study points toward the former: a very slight superiority confers a disproportionate advantage, and it appears that the capable are not actually or quantitatively very far ahead of the rest of us who are not morons. If you have wondered what it is like to be an Einstein, this semi-technical book will tell you.—$2.65 postpaid.—*A. G. I.*

A GUIDE TO SEXING CHICKS

By Charles S. Gibbs, Prof. Vet., Mass. State College

THIS very practical little book reveals the oriental method of deciding, shortly after hatching, whether chickens are going to be nice productive hens or merely noisy roosters, which the author learned first from Chinese farmers.—$1.35 postpaid.—*A. G. I.*

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COVER

OUR cover illustration this month, copyrighted by Berton Crandall, shows an 830,000 volt sustained arc-over on a huge disconnect switch being tested in the Ryan Laboratory described on page 84 of this issue. Three seconds were required to form the 10-foot long lace-like arc which contains at least 120 separate parts.

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50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

It is frequently the case that present-day advances in science and industry can be more fully appreciated when there is available some knowledge of what has gone before. The accompanying excerpts from Scientific American for February 1886 were selected from our files for their inherent interest and significance. If you would like to see this page continued as a regular feature of Scientific American, won't you write us a note to that effect?

ORSON D. MUNN, *Editor and Publisher*

CASTINGS—"The presence of occluded oxygen and of oxides in metals has long been recognized as the cause of deterioration of quality which appears as flaws in casting or in reduced strains. The removal of oxides is generally accomplished by adding more readily oxidized substances, like manganese in steel, phosphorus in copper and bronze, and magnesium in nickel."

TRAIN TELEGRAPHY—"The Edison railroad telegraphy apparatus on board the train is all attached to a compact operator's desk, occupying no more room than an ordinary car seat. The apparatus consists of an ordinary Morse key, phonetic receivers, an electro-magnet, a vibrating reed, an induction coil, and a battery. The car roofs are covered with tin and connected electrically by copper wire. As the induction takes place between telegraph wires and the tin roof, it is desirable to have as large a metallic surface as possible. The Morse alphabet of dash and dot is employed, and consequently any operator can work the system. When the key is pressed down to form a letter, the short circuit is closed and the current passes through the primary coil. But the vibrating reed breaks the current each second into five hundred waves, and these electrical waves induce corresponding ones in the secondary coil. The function of this induction coil is to transform the intermittent current into one of high electrical tension."

DEPRESSION—"On all hands the cause of the recent stagnation in trade is assigned, by business men, to overproduction. . . . It has been pertinently remarked that 'putting aside the wealthy classes, there never was a time in which more people could wear silk and broadcloth, have vacations, take journeys, eat ice cream, provide pianos and organs for their families, go to the races, the theater, and the polo ground, than at the present time.'"

WATER—"The Holly Manufacturing Company, of Lockport, N. Y., have just completed the water works at Fond du Lac, Wis. The engines are two compound Gaskill engines, of 3,000,000 gallons each per 24 hours, and pump through 14 miles of pipe to 140 hydrants, etc."

CANALS—"An examination of the relative merits of canal and railway transportation, as illustrated in the case of the Erie, shows that in addition to its want of speed and the inconvenience arising from the winter's deadlock, the canal, all things considered, is the more expensive carrier."

GAS—"It has only been within the past few years that natural gas has been utilized to any extent in either Pennsylvania or New York."

OTTO GAS ENGINE—"The important case of Otto *vs.* Steel, which had been fought for sixteen days before Mr. Justice Pearson, in the chancery division of the High Court of Justice, London, England, ended on December 19, with judgment for the plaintiff. The point at issue was the validity of Dr. Otto's patent of 1876, which was strongly contended for already in Otto *vs.* Linford some years ago, and then decided in favor of the well-known inventor."

SHELLS—"A novel departure in the line of gunnery is a shell or projectile, the principle of which is to fill the two compartments of the shell with chemicals which, in themselves, are harmless and non-explosive, and to manufacture an explosive compound—nitro-glycerine—by combining these ingredients during the flight of the projectile."

FUEL—"The house of the near future, the *Boston Journal of Commerce* thinks, will have no fireplace, steam pipes, chimneys, or flues. Wood, coal, oil, and other forms of fuel are about to disappear altogether in places having factories. Gas has become so cheap that already it is supplanting fuels."

FARM TRACTOR—"The novel locomotive herewith illustrated carries and lays its own track, which consists of an endless chain passing around two sprocket wheels, one at each end of the locomotive, feet for resting upon the ground, and jointed side rail sections forming the track. The rear sprocket wheel is driven by a suitably arranged steam engine. One man can manage the locomotive and a gang of ten plows."

ELECTRICAL PATENTS—"Prior to the year 1881, electrical apparatus was only a Patent Office sub-department under the general classification of philosophical instruments. In that year, it was made into a separate class. Since then, the number of inventions has multiplied so rapidly that during the past year the electrical department was given nine classes in place of one. The greatest epoch in the history of the art was in 1876. Before that time, there had been but 1973 patents . . . for electrical inventions. Since then . . . 8000 new patents."

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¶The Attack by Modern Science on the Motor-Car Accident Problem, by John Henshaw Crider.

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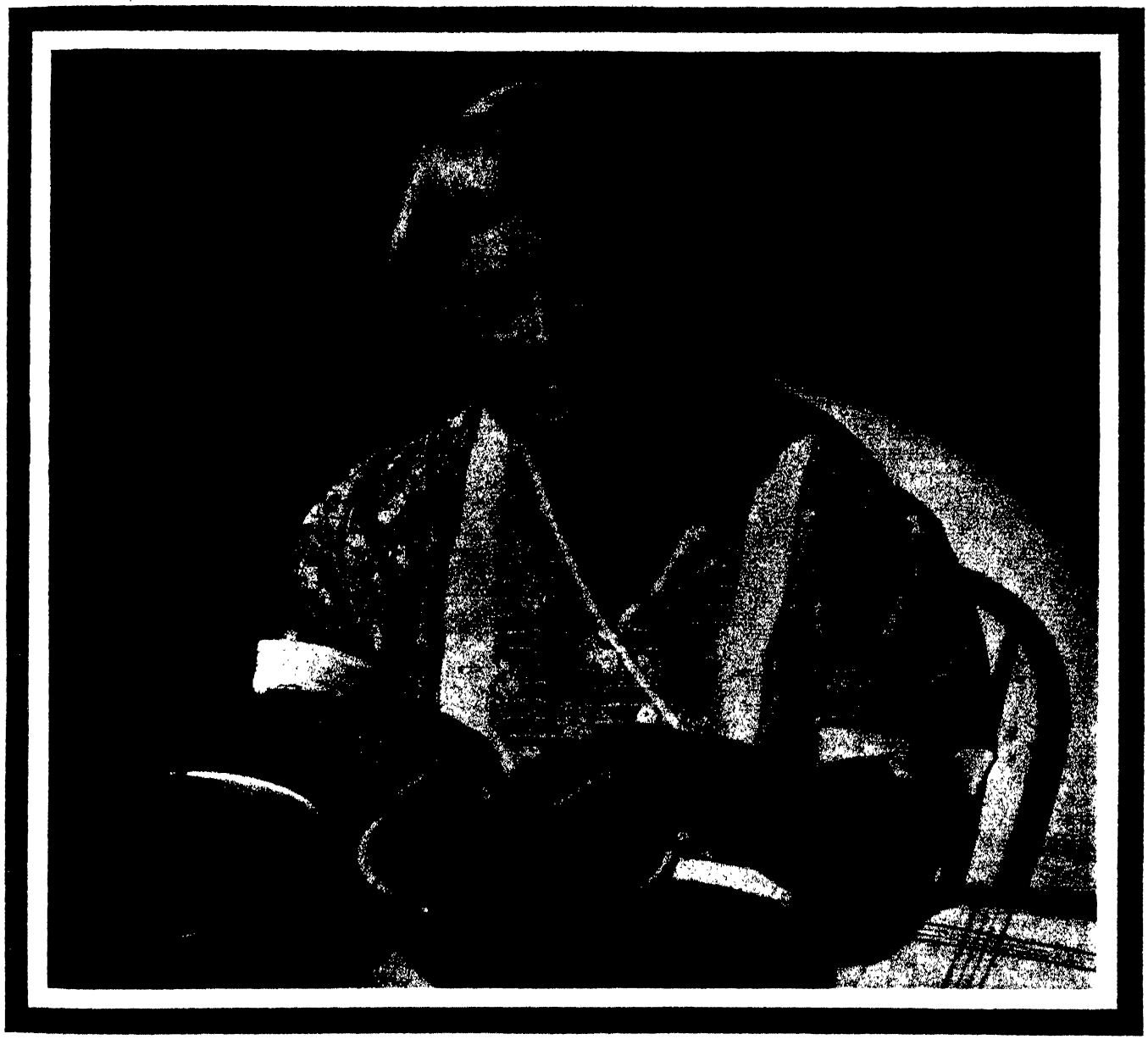

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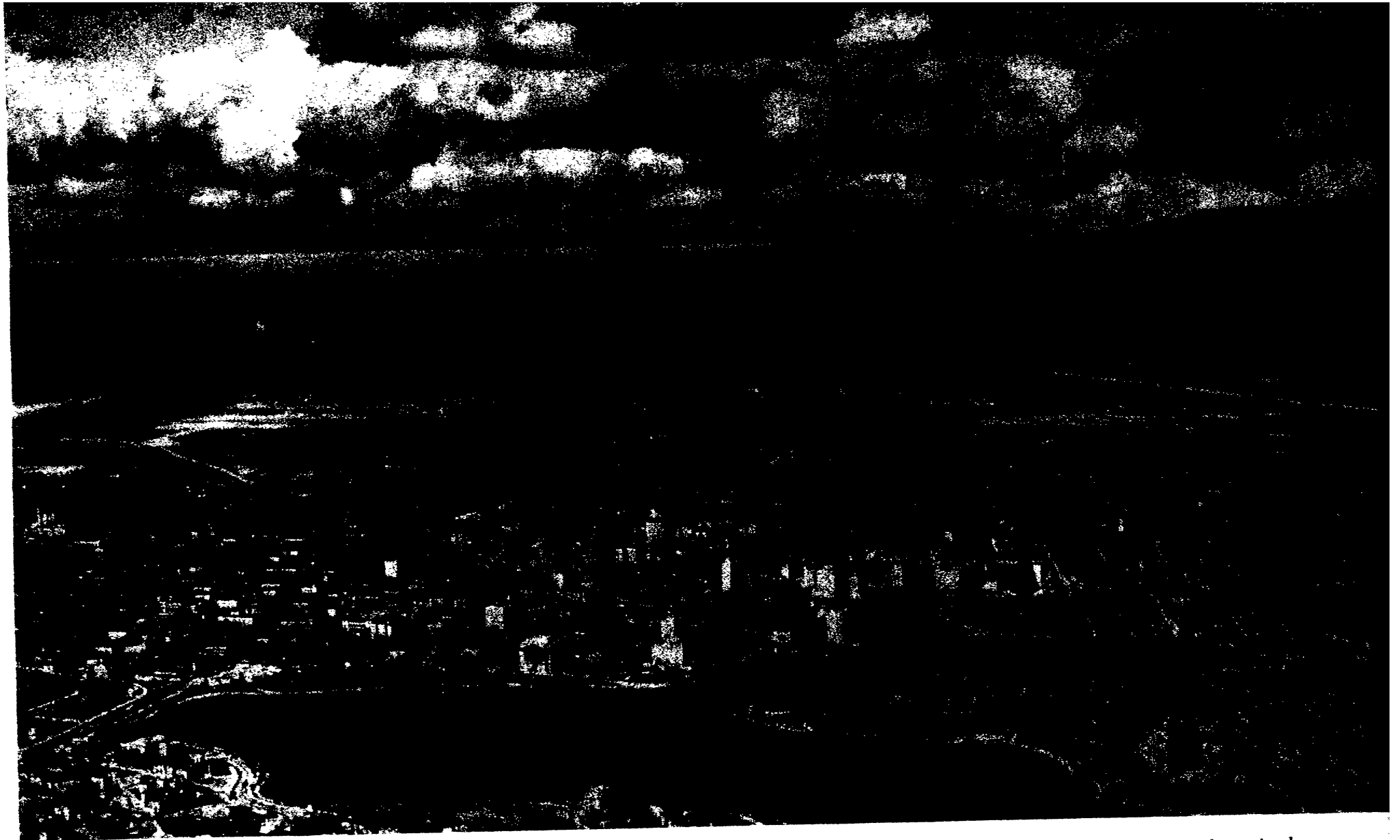

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TO END SAN FRANCISCO'S ISOLATION

NOT content with half-way measures, San Francisco, isolated on the peninsula at the left center near the Pacific Ocean horizon, is being connected to the mainland by two important bridges. Stretching from Oakland, in the foreground, is the San Francisco-Oakland Bay bridge which has one foot (or, rather, two anchorages and a tunnel) on Yerba Buena Island. Close scrutiny shows in the distance two piers of the famous Golden Gate Bridge, the great cables of which are now being spun.

Dangerous concentrations of carbon monoxide may frequently be the cause of accidents such as this one

DEATH AND CO

Unexplained Accidents . . . Asleep at the Wheel . . . Carbon Monoxide (CO) Responsible . . . How to Avoid Dangerous Concentrations of the Gas

By LAWRENCE A. CLOUSING
School of Engineering, Northwestern University

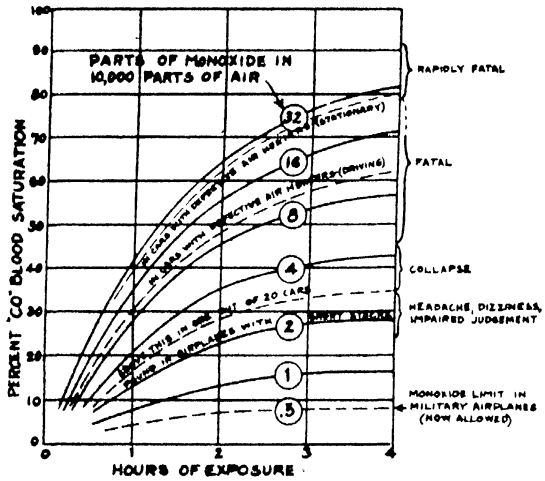
ONE of the definite causes of motor-car accidents that has not received sufficient attention in the past is the presence of carbon monoxide in closed cars and in the closed cabs of trucks. Particularly vicious is this menace in winter time when the windows are often tightly closed. The accompanying article deals specifically with the results of an investigation of the carbon monoxide content in cars as found in a survey of motor vehicles picked at random on public highways. From these findings it is possible to draw a complete picture of the situation and to recommend remedies for it. Every motor-car driver will be protecting his own life and property, as well as those of others, if he will read carefully and be guided accordingly.—*The Editor*

WHEN, each year, there are 500,000 unexplained highway accidents, and when the prevalence of accidents from sleeping at the wheel is on the increase, something must be wrong. Liquor and high speed cannot be totally to blame. There must be other causes. There are! One cause, insidious in effect and heretofore unsuspected, has recently been brought to light as a result of a thorough investigation of the automobiles now operating on our highways.

It is carbon monoxide—CO. Not that carbon monoxide actually kills people by asphyxiation while they are driving; it is rather the drug effect of this gas—producing sleepiness and inalertness—which is the great danger to drivers. Unbelievably small concentrations in the car's interior, breathed for an hour or two, can produce sleepiness, headache, and impaired judgment, yet the driver will not be fully aware of his condition.

It is alarming to note, therefore, that one car in 20, including trucks, contains dangerous quantities of carbon monoxide in the driver's compartment. Winter, with its closed window driving, makes it all the more important that drivers have a thorough understanding of the carbon monoxide danger.

NOT long ago, for example, a truck driver was found dead at the wheel in his truck parked along a road. A report on the case stated: "While dead men tell no tales, a half-empty box of headache tablets, and footprints in the snow around the car, bore mute evidence that the driver had suffered headaches before the tragedy. Apparently the driver, realizing he was 'groggy,' had pulled off the pavement for the purpose of taking a nap. He was found several hours later seated at the wheel with the engine still running. Later, when a carbon monoxide detector was placed within the cab and the engine started, the detector showed a concentration of carbon monoxide which would cause the death of any normal person



CO concentrations. See the text

after only a brief exposure. It was not feasible to test the car on the highway, but there is little doubt that the concentration then would have been sufficient to result in drowsiness, if not complete collapse."

An examination of the exhaust system of the death truck disclosed the fact that the seam of the muffler contained a rip which permitted exhaust gases to be blown inwardly against the floor boards. Openings around the floor boards then permitted the deadly gas to filter into the car. There were also leaks in the flange connecting the exhaust manifold and exhaust pipe. Furthermore, the carbureter of the engine was in such poor adjustment that five to ten times the ordinary percentage of carbon monoxide existed in the exhaust gases.

THE effect of carbon monoxide on human beings depends on the concentration of the gas and the length of time breathed. Chemically it reacts with the hemoglobin of human blood in nearly the same way that oxygen reacts. Normally the blood absorbs oxygen from the lungs and carries it to the various parts of the body in a constantly circulating process. If, however, carbon monoxide is in the atmosphere, the hemoglobin combines with it instead of with oxygen. In fact, the affinity of hemoglobin for the deadly gas is about 300 times as great as it is for life-sustaining oxygen. Therefore, in an atmosphere in which there is one part of carbon monoxide to 300 parts of oxygen —or 1500 parts of air, since only 20 percent of the air is oxygen—or, restating: seven parts carbon monoxide to 10,000 parts air—50 percent of the blood would in time become saturated with carbon monoxide. This is sufficient in most cases to cause death. Hemoglobin which has combined with carbon monoxide is no longer capable of carrying oxygen. Since the number of oxygen-carriers is now reduced, the body suffers because of lack of oxygen and for no other reason. Thus, in time, a form of suffocation takes place, even though the victim may breathe.

The exact degree in which this reaction takes place is illustrated in the curves shown at the left, where percentage of carbon monoxide saturation of the blood is plotted against time of exposure, and the attendant physical effect is indicated at various blood saturations. When from 25 to 35 percent of the blood is carrying carbon monoxide, the person may suffer headache, dizziness, or nausea as a result of oxygen deficiency. A person in such a state can not make the necessary instantaneous decisions required in driving a car; his mental processes are too sluggish.

For example, a truck driver, after being on the highway for several hours, drove at moderate speed into the rear of a parked truck, and was killed. Examination of the dead driver's blood very readily showed a carbon monoxide content which would seem to account for his poor driving judgment and lack of alertness, although the damage to the truck prevented examination of it for the sources of carbon monoxide content in the driver's compartment.

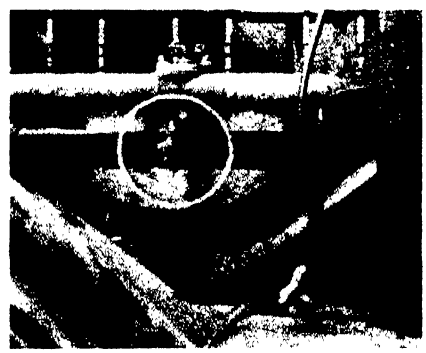
IN another case, a driver in a pleasure car, after several hours at the wheel, drove into a street car safety loading zone. He struck and killed one person, while two others escaped injury by jumping clear. He acted drunk. Police took him in hand and charged him with driving while intoxicated. However, the police physician discovered no alcohol in the man's blood but, instead, discovered the presence of carbon monoxide.

It is seen from the chart that it is less harmful to breathe a relatively high concentration for a very short time, than it is to breathe a small concentration for a long time. As low a quantity as two parts in 10,000 is sufficient to cause headache, dizziness, and impaired judgment, if breathed for three to four hours, while four parts in 10,000 may even produce collapse, and may be fatal. These are the effects upon an average person. A person small in stature, or a child, is more readily affected.

In the investigation which was previously mentioned and which was carried out by the Cities Service Oil Company in co-operation with the highway officials of seven eastern states, 200 cars were stopped at random along the public highways, and were thoroughly investigated for carbon monoxide content, exhaust leaks, and reactions of passengers to long drives. These tests revealed that one car in 20 contained a dangerous concentration of carbon monoxide, and about one out of two cars contained traces of the gas, indicating, thereby, a potential danger.

Carbon monoxide may get into the closed interior of cars in many ways. It has been found that exhaust gases may come in through an open rear window. In any car not streamlined, the vortices behind the car—air current whirlpools—may catch the exhaust gases and fling some of them back into the car through a rear window. In cars such as station wagons, having only a curtain in the rear, carbon monoxide from this source may be bad.

IT is possible to pick up quantities of this dangerous gas from a car ahead in traffic. Some cars have ventilators or heaters which draw air from the front end of the car. With such an installation, the pick up of exhaust gases from a car ahead is accentuated. Large quantities of the gases are given off by buses or trucks on heavy pulls or at high speed. There is on record an actual case of a car having a front ventilator installation which, although in perfect condition itself, drew in enough carbon monoxide, while stalled in traffic behind a heavy vehicle, to affect the alertness of the individuals in the car and cause several headaches. The concentration was high enough to have caused collapse and fatality in two hours. Although this was an extreme case, it no



Exhaust gasket leaks should always be repaired immediately for safety

doubt happens frequently, and may be the cause of many highway accidents.

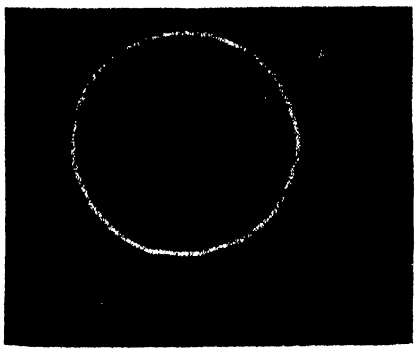
In the case where the heating of the car is accomplished by hot air taken over the exhaust manifold, the carbon monoxide content of a car is invariably high. In many such cars tested, it was found that they were lethal chambers, as much so as those used by the state of Colorado to impose the death penalty on convicts. Any gas leaking through the exhaust gaskets is forced into the car. Asphyxiation of many motorists has been traced to this cause.

In one case, two people were asphyxiated while the car was parked. A

gas analysis of the atmosphere of the car showed that within five minutes after the engine was started a lethal atmosphere existed. The car had an exhaust manifold heater, yet it was disclosed on examination that the leak of exhaust gases from the exhaust manifold into this heater was not sufficient even to cause an audible sound. Even the air in the car, though of fatal concentration, contained no warning odors. The windshield of the car bore a sticker certifying that the car had satisfactorily passed the state examination for safety devices only a few weeks before the tragedy. Such is the insidious nature of carbon monoxide.

THE crankcase breather may be another source of carbon monoxide. This vent of the crankcase is sometimes under the hood. In such cases the gases which blow by the piston rings in an engine during the combustion stroke are released under the engine hood. Thence they may work into the interior of the car, where, added to gases from other sources, they may cause trouble. It takes but a "glassful" of carbon monoxide in the ordinary car to give it a dangerous concentration of the "poisonous" gas. This much is contained in a "hatful" of exhaust gases.

Last year carbon monoxide killed 500 to 700 persons who operated their automobile engines in garages with closed doors either intentionally or unintentionally. A small car can render the atmosphere of a single-car garage deadly within five minutes with the engine running and the doors closed. Breathed, it will produce asphyxiation in a short time. These facts are fairly well known, but it is against the effects of low concentrations of carbon monoxide which



A broken muffler discharged exhaust gases against the floor boards

are insufficient to cause death that the driver must guard.

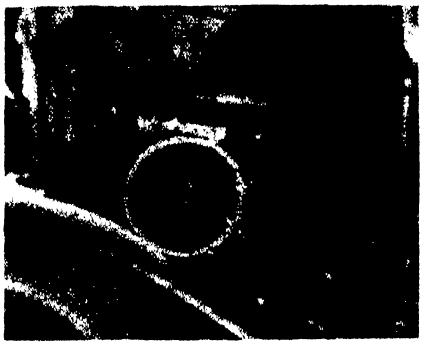
The driver's best safeguard against carbon monoxide is good upkeep of his car. The exhaust system of the car should be kept tight. Leaky gaskets or connections should be replaced immediately, and the entire exhaust system checked at intervals. The floor boards should be kept tight and properly covered. There should be no opening, by means of which gas can seep in, connecting the engine with the driver's compartment of a car.

It is very important to see that the engine combustion is proper, and that the carbureter is properly adjusted. The ignition system should be kept in good condition. Proper adjustment of the carbureter not only prevents large concentrations of carbon monoxide in the exhaust gases, it saves fuel as well.

Another common-sense rule proposed by the National Safety Council, a body which has made considerable study of automobile accidents, is this: "If you drive long hours on the highway, stop occasionally for a 'breathing spell.' An occasional pause to exercise in fresh air not only tends to replace with oxygen any carbon monoxide you might have breathed during the preceding couple of hours, but the resulting relief from muscular and mental tension will make you a safer driver." This is proposed because the union of carbon monoxide and hemoglobin is not permanent. If fresh air is breathed, the carbon monoxide is displaced by the oxygen, and the blood returns to normal, absolutely unharmed by its contact.

IN airplanes at high altitudes, the effect of carbon monoxide is even more dangerous than in motor cars. Doctor David A. Myers of the Medical Division of the Army Air Corps states: "The ability of the blood hemoglobin to absorb oxygen depends largely on the percentage of available oxygen in the air, which decreases as altitudes are reached. Exposure to carbon monoxide decreases the ability of the blood to absorb and carry oxygen; therefore the degree of anoxemia (lack of oxygen) produced by breathing a given concentration of carbon monoxide at 14,000 feet should be much greater than that from breathing the same concentration of carbon monoxide at sea level. There are no data available on this phase of carbon monoxide and its effects on man in the literature. Research along this line should produce much useful information. At the present time whenever a casualty occurs in the Air Corps, blood specimens are obtained and examined for carbon monoxide. Efforts are being made to check frequently all cockpits and cabins for carbon monoxide."

The Army and Navy Air services have specified that one half of one part in 10,000 parts air is the limit of carbon monoxide content they will allow in airplanes. This figure was arrived at as a result of many tests and much research. It was known for some time that in military airplanes with short stack radial engines the exhaust gas was breathed by the pilot to a certain extent. Tests showed that sometimes the pilot breathed air of three parts carbon monoxide in 10,000 parts air. When it was learned by Army Air Corps authorities that three parts in 10,000 caused dizziness and very nearly collapse if breathed for three to four hours, there was a change in the design of those airplanes, much to the pleasure of the pilots. Much of the disagreeableness and air sickness of flight in airplanes of older design and perhaps many of the



Crankcase breather pipes may be a source of fatal carbon monoxide

unexplained accidents were due to carbon monoxide.

While we are concerned here primarily with carbon monoxide (CO), the effect of other constituents of exhaust gases from automobile engines may be of interest. Other products present in gasoline engine exhaust gases are carbon dioxide, oxygen, methane, hydrogen, and nitrogen. There are indications of the presence of small quantities of various aldehydes, but in concentrations too low to produce any toxic effect. When tetraethyl lead is added to gasoline, it is thrown out of the exhaust in particles of lead sulfate, lead oxide, and metallic lead, all of these compounds being solids at ordinary temperatures. In airplanes, some of these particles may reach the cockpit in fine dust.

However, it has been found that this lead dust has no deleterious effect on humans in small quantities. Lead retained in the lungs after inhaling dust in an exposure chamber averaged but 15 percent of the total inhaled, showing that considerable amounts are exhaled or deposited in the nasal passages or throat, where they are swallowed or expectorated. This behavior of the lead that remains in the air as suspended matter greatly reduces the danger of lead poisoning. In cases where animals have been exposed to lead dust air for 188 days, no lead poisoning resulted.

SOME of the other constituents present in engine exhaust gases, while not necessarily harmless if breathed in large quantities, are really harmless in practice because in the concentration in which they would be breathed the effect compared with that of carbon monoxide would be negligible.

OUR POINT OF VIEW

Pacifistic Piffle

"THERE is still hope for China if the Chinese will keep up their resistance long enough for Great Britain and the United States to realize the inevitable implications of Japan's further encroachments on China. Given this realization, the opportunity will soon arise for successful and comparatively easy intervention by the two great sea powers, and the grandiose plans of the Japanese war lords will tumble like a house of cards about their Chauvinistic heads." This statement quoted from "The Problem of the Far East," by the Editor and published in our November Navy Number, judged against the background of the context of the complete article and of the numerous expressions of this magazine's hope for lasting, honorable peace, means just what it says. It means, as our regular readers know, that America is honest enough to observe the letter and spirit of its treaties and believes that, when others are not so honest, displeasure should be expressed by the two nations mentioned, acting in concert in the cause of peace and justice for all mankind. Precisely that has happened, though without premeditation, for a recent newspaper headline reads: "U. S. and Britain warn Japan on North China activities; Hull cites treaty rights."

Apparently, however, Scientific American did wrong in suggesting "honesty" and "honorable peace" and in dragging in that opprobrious word "patriotism" to disturb the peace-cultists. Frederick J. Libby, writing in *Peace Action*, of which he is Editor, quotes the single paragraph at the head of this discussion, with the unequivocal headline: "Editor of Scientific American wants war!"

Droll! Droll and ridiculously naive!

That is not all. Like a bad rumor, passed over backyard fences and expanded with each reiteration, that yarn has grown to the point where this journal is said to advocate extreme measures in the Orient. Mr. Warren D. Mullin, head of the labor department of the National Council for the Prevention of War, was recently quoted by the *Sheboygan Press* as saying at a peace meeting in that city that "A magazine, Scientific American, suggested running out the Japanese and then ministering to the Chinese ourselves, and taking a nice profit doing so."

Droll! Very, very droll!

We will not argue. There is no argument. We answer both of the quoted statements with one categorical denial. Both are untrue, misleading, and libelous. They exemplify the methods of the myopic tribe of pacifists. These gentry seem incapable of making a logical evaluation of a whole subject but rely upon innuendo and misstatement to gain their ends. Their vocabulary abounds in catchwords and cant. Theirs is wishful thinking; through an emotional approach to the war problem—citation of the blood and horror *results* rather than the inept, stupid diplomacy *causes*—they would banish war and assure permanent peace.

On the other hand, Scientific American, as a magazine, and its staff as individuals, are pacifists of the Realist school. Never in modern times have we advocated, even suggested, military action against another nation. We *have* urged attainment of adequate national defense, and will continue to do so—in the cause of peace; for we face the facts of history. This country has been drawn, *unprepared*, into at least three foreign wars. On August 3, 1842, a Congressman announced that "we have no prospects of war. . . ." In April, 1896, Representative (Uncle Joe) Cannon said, "I want to say that I do not believe we will have war during the coming year. . . . I doubt if there will be any during this century or perhaps the early years of the next century." The late Dr. David Starr Jordan said in 1914, ". . . Humanly speaking, it (the ever-impending great war of Europe) is impossible. There is too much at stake." A few months later the war flame was ignited in Europe, with consequences to ourselves unpredictable and beyond our power to avert. Our wars with Mexico in 1846, with Spain in 1898, and with Germany in 1917 might have been prevented, or at least our ghastly losses in men and money would have been held to a minimum, had we been prepared.

Scientific American is in the thick of the fight for peace. This we have stated time and time again. But it must be peace with honor—no grovelling peace in which we bend the knee at the whim of any nation that wishes to command us.

In fighting this cause for honorable peace through a preparedness that forces other nations to respect our peaceful national policies and refrain from attacking us, Scientific American listens not to emotional, vociferous minorities; to radicals who care not for peace but make a pretense of doing so to cloak their subversive activities; nor to defeatists who see only the blood of war and not the education and diplomacy that can prevent the horror. Scientific American knows that no amount of wishing can stop war, nor can quotation of half-truths or millions of names on an I-won't-fight pledge. Education will, but it must be sane, logical education. And while the world is getting a proper understanding of the disease and working out the remedy, the nation must not be spineless. Preparedness will be our finest peace insurance during those long years. Being a non-aggressor nation, the United States will never use its forces of national defense unjustly. Being, nevertheless, a dynamic nation, a nation of widespread and active interests throughout the world, we can not afford to risk attack by some nation jealous of our wealth, our prestige, our progress, and our peace.

When the emotional fever of the peace-at-any-price propagandists has burned itself out, we shall, perhaps, enter an era of permanent, honorable peace.

Game Increase

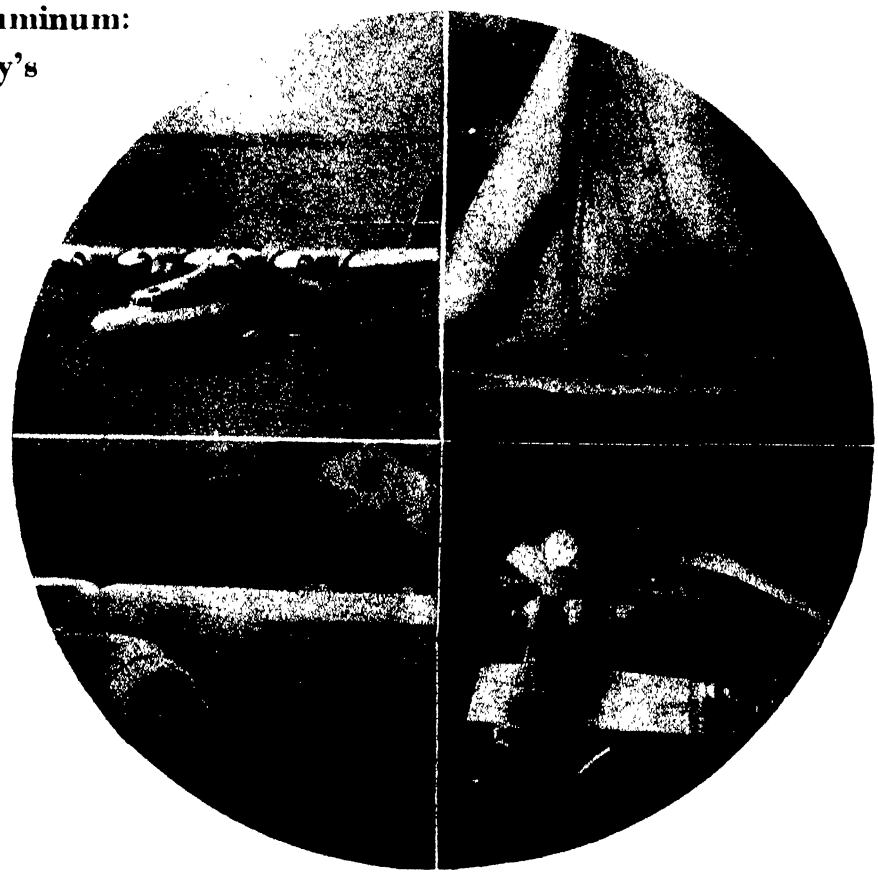
ANTELOPES, deer, elk, moose and mountain sheep, long threatened with extinction, have been staging a come-back. In our National Forests there has been a general increase in the past several years in the numbers of these game animals, according to a report from the Forest Service.

The last estimate shows an increase of about 600 in the number of antelopes in western National Forests during the preceding twelve-month. This brought the total to about 15,000. Deer increased by about 100,000, bringing the total to 1,040,000. Elk increased from 115,000 to 120,000; and the count of moose went up to more than 8000. Mountain sheep increased to 13,000; but mountain goats decreased slightly to 17,900.

The Forest Service, in practicing game management, observes the principle of "sustained yield" of all forest resources. The aim is to develop and maintain as much wild-life—in coordination with other forest values—as the forests can support. Judging from the results quoted above, the Service is doing a fine job preserving the larger species of game animals.

ALUMINUM'S FUTURE

The Next Fifty Years of Aluminum: In the Light of Yesterday's Progress and Tomorrow's Research Possibilities



Aluminum's present: Lightweight alloys of great strength are used in the *China Clipper*, in yachts and ocean liners, in large-capacity motor trailer units, in streamlined railroad trains, and elsewhere. What does the future hold in store?

By W. S. McARDLE

ON the eve of aluminum's second half-century of commercial service, it is interesting to pause for a moment to consider the past and the future.

In the early eighties, aluminum was an expensive metal with few uses and a dubious outlook. Charles Martin Hall, 50 years ago this February, revolutionized the entire aluminum industry through the development of a process for electrolytically producing the metal from its oxide. Almost overnight, the price of aluminum dropped; and 50 years have seen the creation of many diversified markets. Today, aluminum ranks fifth in point of tonnage among the world's metals, being surpassed only by iron (and steel), copper, lead, and zinc. Dreams of the eighties have come true; aluminum trains, bridges, and buildings are actualities! What the next 50 years will hold for the metal is largely a matter of conjecture, tempered by yesterday's records and tomorrow's conditions.

In its struggle for a place in industry, aluminum was endowed with a number of outstanding characteristics which, when taken collectively, were possessed by no other single metal. Briefly summarized, these included lightness, resistance to corrosion, good electrical and heat conductivity, excellent workability, non-toxic properties, and attractive appearance. These properties, either individually or in combination, have accounted for practically all of aluminum's uses, and it is reasonable to assume that future applications will likewise be based on them.

THE growth and development of the aluminum industry have been closely intertwined with research. Most of the major events in the aluminum world have been preceded by months of patient endeavor in laboratories. Quite naturally, then, we turn to research for our first clue as to what the future may hold for the metal.

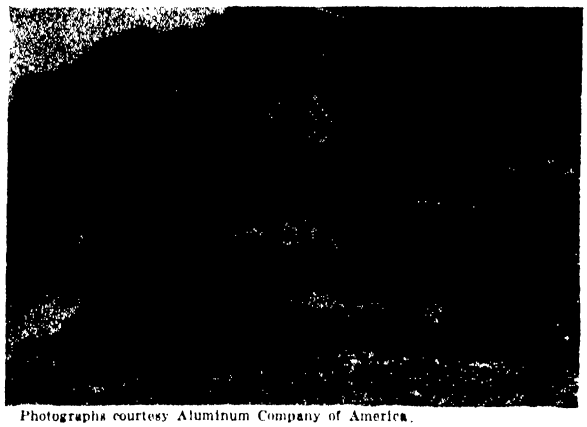
From the discovery of the electrolytic process in 1886 down through the World War, practically all work with aluminum was confined to about three alloys. While the German metallurgist, Wilm, had worked out methods of heat-treatment designed to strengthen and improve the working characteristics of the metal, the development of the strong, wrought alloys of aluminum in the United States came almost entirely after 1920.

Between 1920 and 1935, there were astonishing strides in the development of aluminum. Scores of new alloys appeared with characteristics far better fitted to cope with the conditions surrounding their use. Tensile strength was increased to a point equalling that of structural steel, and rapid strides were made in the development of corrosion-resisting alloys.

But the ultimate is by no means in sight; the future will see aluminum alloys with still better properties. While it is true that for present needs the aluminum alloys used are adequate, tomorrow's needs will be even greater and it will be necessary to create new aluminum alloys to cope with them.

At present, the alloying elements or "hardeners" commonly employed with aluminum are copper, magnesium, manganese, silicon, and nickel. Occasionally, tin, titanium, and chromium are added. In many cases, the addition of a minute quantity of one of these is sufficient to change the properties of the alloy. By shifting the proportions, an almost limitless variety of properties is achieved.

Commercial application of known alloys must be co-ordinated with known process development, such as jointing, plating, and surface finishing. Add this effort to the rapid strides that will be made in all industries, many of which will need aluminum, and a half-century is too short a period for a slowing up in aluminum progress.



Photographs courtesy Aluminum Company of America

Husky aluminum-bodied trucks at Boulder Dam haul 25 tons of rock and earth per load

One of the chief problems with all metals in the past has been that of corrosion. This single item has accounted for the destruction of millions of dollars' worth of property annually. Aluminum is better fitted than many metals to resist corrosion attack, in that it has a protective oxide coating on its surface which halts further oxidation. This coating, which nature has given the metal, may be built up by means of an anodic treatment, which materially improves its resistance.

Toward a complete solution of the corrosion problem, aluminum research facilities have been directed for several years. While the anodic treatment is a step nearer the goal, even greater progress may be made in the development of new aluminum alloys, designed to resist corrosion more completely. Eventually, then, corrosion-proof aluminum alloys may become a reality and the metal will be employable in countless places where even the advanced treating processes of today have proved inadequate.

ACCURATE as is the present system of manufacturing controls, the future will see greater improvement, and the various processes may in time be controlled almost entirely mechanically, thus eliminating the chances for error which the personal element presents.

Scientific progress will naturally be reflected in improved metal properties. But how will tomorrow's industry be able to utilize the advanced alloys of aluminum?

Undoubtedly, one of the first industries to take advantage of aluminum progress will be the transportation industry. Today, aluminum alloys are used in the manufacture of railroad trains and electric street cars, automobiles, buses, and trucks, airplanes and dirigibles, and marine vessels. Common to all are four objectives: speed, safety, comfort, and economy. The light alloys of aluminum have done much to foster these aims. Union Pacific's streamlined train shattered all records by crossing the continent in 56 hours, 55 minutes, with a fuel cost about equal to that of an expensive automobile. Diesel-powered, and fashioned almost entirely of strong aluminum alloys, it set a new mark in railroad efficiency. With 13 years of experience in railroad rolling stock construction, the experimental stage has passed and the era of aluminum in railroad construction is becoming a definite reality.

Contemporary air-liners are constructed almost entirely of aluminum—wings, motor, and fuselage. With ever-increasing pressure being brought to bear on aviation companies for ships that will fly farther and faster, materials must keep pace with design. Super alloys of aluminum will provide airships for the future that may hurtle through the stratosphere at a thousand miles or more an hour, bringing New York and London within a scant three hours' journey of each other, and permitting travelers to circle the globe with the sun.

Aluminum table service is undimmed by time, food, or fingerprints

Applications for the metal on shipboard in the past have been comparatively few. Aluminum has been used on occasion as a material for masts on racing yachts. Vanderbilt's *Rainbow* scudded to victory in 1934 under a mast constructed of aluminum alloys. Notable among boats built chiefly of aluminum have been the British-owned luxury cruiser, *Diana II*, and the *Interceptor* of the Royal Canadian Mounted Police. In *Diana II* strong aluminum alloys were utilized for such applications as shell plating, deck stringer plates, tie plates, and deck bolts. Ice box, cooker, lockers, and cupboards in the galley are aluminum, as are the water-tight doors between the bulkheads. Both stem and keel are formed of aluminum alloy plate, while other incidentals such as screws, roves, and nails are made of the same metal. The boat carries an aluminum mast and an aluminum motor dinghy.

The argument of light weight is quite as important at sea as elsewhere. Eventually, ocean liners will be streamlined above the waterline as well as below, as a practical aid to speed and efficiency. Weight economy will play a big factor in the choice of materials.

To take a single example of weight saving made possible through strategic selection of materials, consider insulation. In the past, refrigerator rooms, bulkheads, and so on, have been insulated chiefly with cork or magnesia. Roughly, cork weighs 10 pounds per cubic foot; magnesia, 18 pounds. A newer material now used in liners and warships is crumpled aluminum foil, which is equal to cork or magnesia in insulating value, but weighs three ounces per cubic foot!

Even the weight-saving possibilities of the use of aluminum in paint are somewhat startling. In one instance, use of aluminum paint for a cruiser permitted a weight reduction of over 100,000 pounds. This paint, incidentally, has won an important place in many industries because of its appearance, durability, and covering qualities.

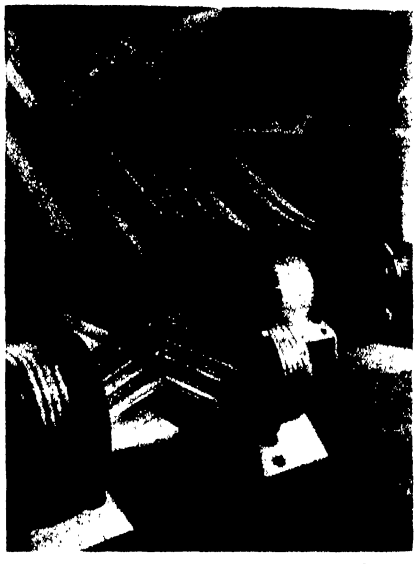
To attempt to list the probable applications of aluminum in tomorrow's vessels is a matter of guesswork. Highly resistant to corrosion at present, and likely to be more so, aluminum is a logical choice for exposed metal work. Should the time arrive when we shall have aluminum alloys that are completely resistant to corrosion, applications for the metal on shipboard will be practically unlimited.

Turning again to land, we examine another field for aluminum—the automobile industry. Aluminum and the automobile were "kids together." Naturally, automobile manufacturers quickly took advantage of the light weight of

Aluminum's progress in art exemplified by Laurent's "Goose Girl"

aluminum. As early as 1902, cars had aluminum bodies and numerous engine parts of the metal.

Unfortunately for aluminum, price competition changed the entire picture, and cheaper materials were employed for many parts. More aluminum, however, is being used today by the automobile industry than ever before, although its applications are limited to



Escalators use aluminum for efficiency and attractive appearance

such vital parts of the power plant as the pistons and cylinder heads. It remains for the future to create a need for a car in which the inherent lightness of aluminum will make possible a saving in operating costs sufficient to overbalance the high initial cost.

Further demands for economy will undoubtedly result in a more general adoption of the Diesel engine in the motor car of the future. Since engines of this type require more space and more metal than present motor car engines, they will be lightened by the use of metals such as aluminum. Many of today's Diesels have aluminum bedplates, crankcases, and aluminum cylinders. Tomorrow's applications will likely be even more numerous.

In the truck and bus, aluminum is rapidly regaining the market it has lost in the automobile. Economy of operation requires a reduction in dead weight, and both truck and bus operators have found that, although aluminum costs more initially than the materials formerly used, over a period of time the saving in non-productive weight resulting from aluminum construction will make possible an ultimate saving in operating cost sufficient to compensate for the metal's greater first cost. As a result, aluminum is used almost exclusively in bus body construction.

Three years ago, engineers completed the reconditioning of an important highway and electric street railway bridge in Pittsburgh with a strong aluminum alloy floor system. A total of 750 tons was saved in the weight of the bridge, and the useful life of the structure was increased at least 25 years. This important event will undoubtedly have an influence on bridge construction all over the country. Engineers have watched the work with keen interest and plans are already under way to employ aluminum in similar long-span bridges in other cities.

ONE of the earliest uses for aluminum was in the architectural field. A cap placed on the top of Washington Monument in 1884 was probably the first architectural application for the metal. Since then, millions of pounds of aluminum have found their way into buildings in the form of spandrels, decorative trim and, in some cases, actual structural parts. The Empire State Building's "mooring mast" is fashioned of aluminum and glass. In Rockefeller Center, more than 3,000,000 pounds of aluminum is utilized.

Some theorists claim that the trend toward higher buildings will necessitate the use of light alloy beams and girders in the construction of upper stories to obtain a better distribution of weight.

There is reasonable proof that the present trends in utilitarian architecture will continue—and this means an increasing use of metal and glass. Scientific engineering will create office buildings which are heated in the winter and cooled in the summer—to maintain ideal weather independent of outdoor conditions. Wall thickness will be a matter of inches rather than feet. Proper insulation, such as that provided by aluminum foil, will save fuel in January and keep out the July sun's heat.

One of the first commercial uses for aluminum was in the form of cooking utensils, and its success in that field has been so successful as to warrant no further discussion. The canning industry, however, is keenly interested at present in the development of the aluminum can as a substitute for tin. One of the early investigators along this line was the Point Loma Tuna Packers, of Point Loma, California, which placed on the market in 1933 its "Luxury Brand" tuna packed in attractive aluminum cans. Experiments are being carried on with other types of food and it is entirely possible that the next few years will see the aluminum can as a definite factor in packaging. Advantages of aluminum cans, of course, include attractive appearance and safety (food may be left in opened cans if necessary).

Aluminum is highly resistant to the attack of many chemicals, and it is probable that the future will witness a marked increase in the use of aluminum in the chemical industry. Chemical tanks and tank cars are today fabricated of aluminum. Tomorrow's uses will probably be more extensive, including not only transportation equipment but considerable apparatus used in the actual preparation of the chemicals.

Only a few of the countless other applications of aluminum that appear to have an attractive future may be pointed out by way of illustration. Aluminum alloys are used more and more for steam shovel dippers and dragline booms. Aluminum ink is making its place in the printing industry. Aluminum bars are used for lion cages at the circus, while the man on the flying trapeze entrusts his life to an aluminum platform. The symphony player performs on an aluminum violin, and modern dance orchestras vibrate to the rhythm of an aluminum bass.

Aluminum is the most abundant of all the metals found in the earth's crust twice as plentiful as iron. Perhaps tomorrow will bring forth another Charles Martin Hall who will again revolutionize the industry to magnify aluminum's usefulness a million-fold.

Bridges will be lighter and stronger as aluminum alloys gain wider use in this field. Here is the aluminum floored Smithfield Street Bridge at Pittsburgh, Pa.

A RIVAL OF THE

The Electron Multiplier . . . Bombarded Surfaces Become Electron Emitters . . . Uses in Photo-Electricity and Television . . . May Open New Fields

By VLADIMIR K. ZWORYKIN
Director, Electronics Research
RCA Manufacturing Company

IN the past, the thermionic vacuum tube has held an undisputed supremacy in the field of amplification of small currents. Recently, a rival has appeared which may supplant it in many of its applications. This rival is the electronic device known as the "secondary emission multiplier."

The electron multiplier depends for its operation upon the fact that when certain sensitized surfaces are bombarded with a stream of electrons moving at fairly high velocities, they become emitters, the current emitted being proportional to the bombarding current but many times greater. The factor of proportionality is known as the secondary emission ratio, and for cesiated silver surfaces will range from R=3 at 50 volts to R=9 at 500 volts. It is evident that if a primary beam of electrons is allowed to fall on a first target, and the secondary electrons from it directed onto a second target, producing further secondary electrons, which are in turn directed against another target, the process being repeated n times, the original primary current will be multiplied by a factor

$$I_{output} = I_{input} \times R^n$$

It is obvious that since R will in general be considerably greater than unity and n may be 12 or higher, the overall gain will be very large. The curves shown in Figure 1 are for multipliers of various numbers of stages, showing the overall gain plotted against overall

Figure 3: **A nine-stage photo-electric amplifier shown in comparison with ordinary vacuum tube, type 59**

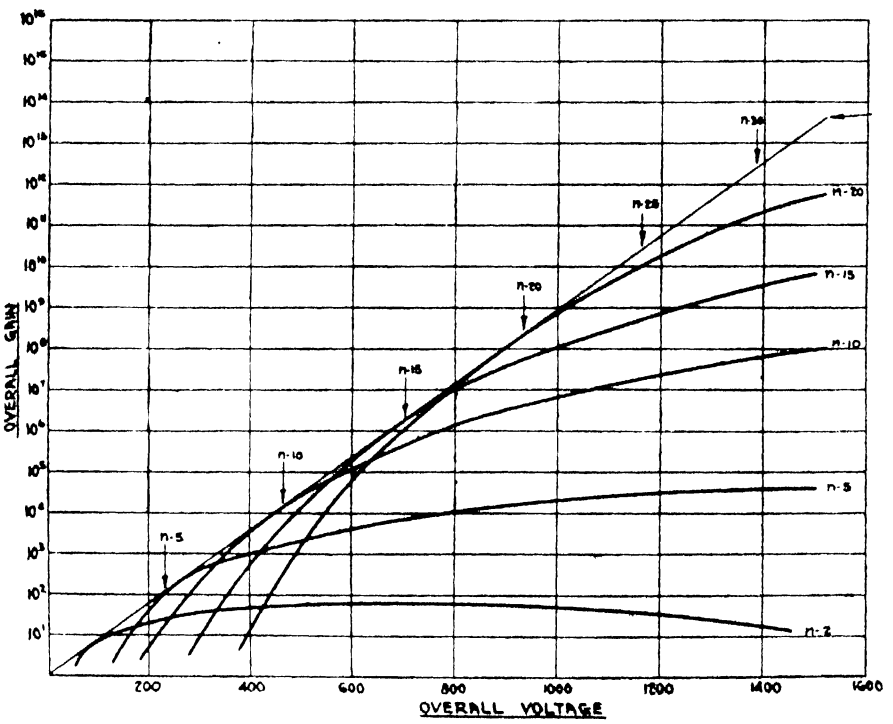


Figure 1: The curves given are for electron multipliers with various numbers of stages, and show overall gain as plotted against the overall voltage

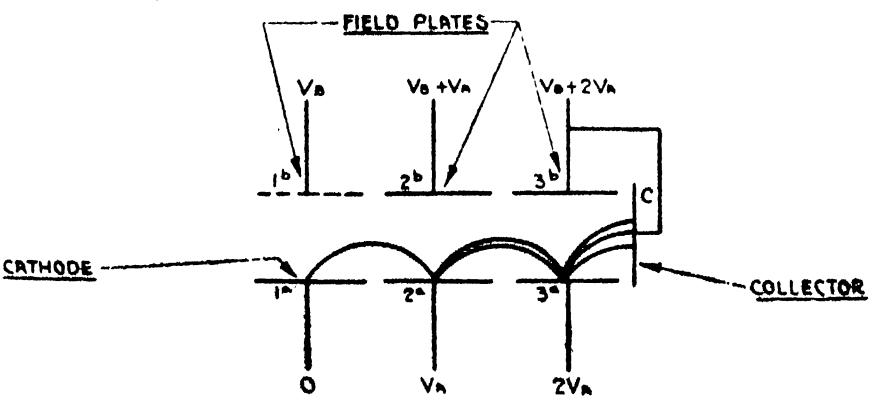


Figure 2: **Diagram of the action in an electron multiplier of the type using a combination of electrostatic and electromagnetic fields. Paths of the electrons are shown as curves above plates marked 1a, 2a, and 3a**

VACUUM TUBE

OUT of the research laboratory steps another result of research in pure science—the electron multiplier — with a bright future ahead of it. Just as the vacuum tube opened many avenues of application as it developed, so may the electron multiplier find places for itself in science and industry. It holds great possibilities for furthering developments in which the vacuum tube as we know it today has reached its electrical limits. The accompanying article describing this new device was written by its inventor, Dr. Vladimir K. Zworykin, a member of our staff of contributing editors, who clearly yet succinctly describes the multiplier, its operation, and gives a hint as to its possible applications.—*The Editor.*

Dr. Zworykin is shown at the right holding one of the new multi-stage electronic multipliers, the action of which is described in the text

voltage. For example, if we have a ten-stage multiplier operating at 800 volts, the overall gain, as indicated by the curve n=10, is a little over a million times the initial current.

There are two principal types of fixed field multipliers, one using the combination of electrostatic and electromagnetic fields; the other an electrostatic field. Both have a number of secondary emissive targets, the electrons going successively from one to the next, not striking any one target more than once, but differ in the means used to direct the electrons along their paths between the targets. Due to the fact that these tubes make use of a fixed number of multiplying impacts or stages, the stability is very great; furthermore, since the power needed to operate the device is a small direct current, it can be very simply supplied.

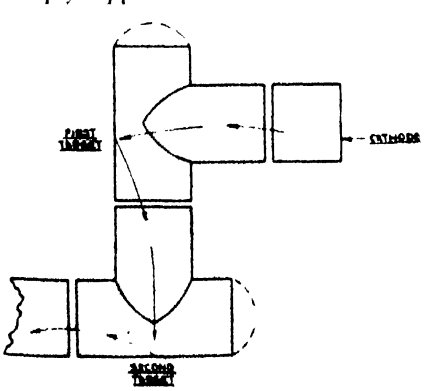


***Figure 4:* Multiplying the electronic stream from a cathode-ray tube**

An example of the first type is shown in Figure 2. The lower row of plates, 1a, 2a, 3a, and so on, are the secondary emissive targets, and are at successively higher positive potentials. The top row of plates, 1b, 2b, 3b, serve only to produce an electrostatic field in the tube at right angles to the axis of the tube. Furthermore, a magnetic field is established at right angles to the axis of the tube and the field between the upper and lower plates (that is, perpendicular to the plane of the paper in Figure 2). Electrons leaving any one of the targets are bent around by the magnetic field in such a way that they strike the next successive target, their paths being sections of a trochoid. These paths are shown as curved lines in Figure 2. The initial source of electrons, of course, depends upon the use to which the tube is to be put.

A FREQUENT application of this type of tube is as a photo-electric amplifier. For this purpose, the first plate of the lower row is made photo-sensitive and photo-electrons emitted when light strikes this electrode are multiplied as described. Secondary electrons from the last target are collected by the electrode C and appear as an output current thousands or even millions of times stronger than the initial photo-electric current. Such a photo-electric multiplier having nine stages and a gain of 1,500,000, is shown in comparison with an ordinary 59 type thermionic amplifier, in Figure 3. This multiplier serves to replace not only the photo-cell but also its associated amplifier.

Its use in photo-electricity is only one of the many applications of this tube. In general, the multiplier can be used wherever it is desired to intensify a small electron current.

Where the multiplier is used to amplify the output of a cathode-ray tube such as the television transmitting tube, the "Iconoscope," the presence of a magnetic field may be undesirable. In this case, an electrostatic multiplier is used. Figure 4 shows diagrammatically how electrons from the cathode-ray device strike the first target, the secondary electrons from the latter being directed onto the second target, and so on through the tube, for as many stages as is desired.

The greater compactness and simplicity of this type of amplifier as compared with the conventional thermionic amplifier is immediately evident. Even more important than this is the fact that these tubes have extremely low inherent noise and can therefore be used to amplify very small electron streams, in general much smaller than can successfully be amplified with an ordinary thermionic vacuum tube. Lastly, these tubes have a perfectly uniform frequency response from the lowest frequency up to many megacycles.

It is too early as yet to try to predict the eventual extent of the application of these tubes, but it seems very possible that they may open up new fields in the realm of the electronics of weak currents.

When Dust Goes Up in Smoke

A Vital Problem in Many Industries . . . Dust Explosion Control Explained . . . Fatalities Reduced . . . New Industries—New Factors

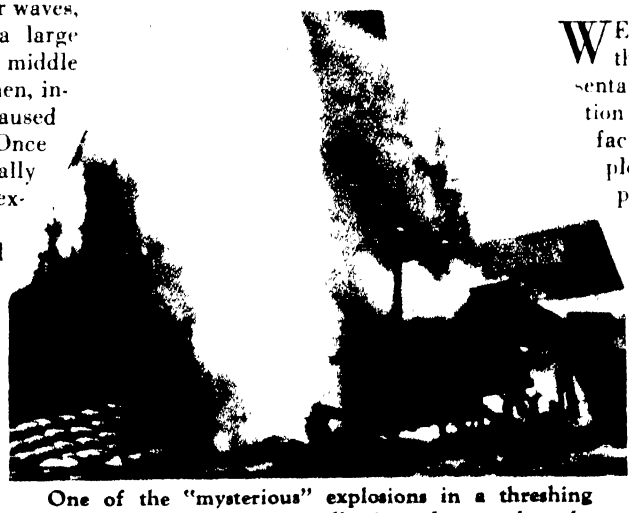
By DAVID J. PRICE, Ph.D.
Principal Engineer in Charge, Chemical Engineering Division
Bureau of Chemistry and Soils, U. S. Department of Agriculture

As part of a recent Farm and Home Hour radio program, the United States Department of Agriculture broadcast a demonstration of an explosion of grain dust from the dust explosion testing station of the Bureau of Chemistry and Soils at Arlington, Virginia, a short distance across the Potomac River from Washington. Just a few minutes before the experimental dust explosion demonstration went over the country by means of the ether waves, a real explosion occurred in a large soybean processing plant in the middle west. This explosion killed 11 men, injured a number of others, and caused extensive property damage. Once again attention was dramatically directed to industrial plant explosions.

What is a dust explosion and how can dust from grain and food products explode? The rapid passage or spreading of fire through a very finely divided dust cloud builds up considerable pressure and produces what we call a dust explosion. It is difficult to realize that when finely divided particles of starch, flour, powdered milk, chocolate, and many other food products are mixed with air in proper proportions, the mixture is as highly explosive as many gases. When this mixture is ignited, however, a violent explosion follows, in many cases causing heavy loss of life and destruction of property and foodstuffs. In fact, more than 28,000 industrial plants in the United States, normally employing more than 1,325,000 persons, may have a dust explosion any moment if the conditions are favorable.

Department of Agriculture records show that during the last 19 years there have been at least 385 dust explosions in connection with the handling, milling, and processing of products largely of agricultural origin. As the result of these explosions 311 persons lost their lives and more than 693 workmen were injured. The property and stock losses amounted to more than 35,000,000 dollars, or an average loss of more than 90,000 dollars for each explosion.

These explosions have occurred in practically all kinds of grain-handling operations—for example: grain elevators, flour and feed mills, and starch factories and in many industries associated with the processing of agricultural products—sugar refining, and the preparation of powdered milk and other food products, insecticides, fertilizers, wood pulp, wood dust, soap powder, paper dust, and many others.



One of the "mysterious" explosions in a threshing machine, found by the application of research to be due to static electricity generated within the machine

Some years ago the Pacific northwest was startled by the large number of explosions in grain-threshing machines in eastern Washington, northern Idaho, and northeastern Oregon. Although local opinion was inclined to attribute these explosions to malicious activity and incendiarism, it has been pretty well established that the majority of the explosions were accidental and made possible primarily by the very favorable climatic conditions in that territory.

To intimate that a stationary machine threshing wheat in the intermountain country between the Rocky and Cascade Ranges is capable of producing sufficient static electricity to ignite explosive mixtures of wheat smut dust and air may seem to be going pretty far. But that is what occurred; the friction produced by the rubbing of the straw on the cylinder teeth of the thrashing machine was responsible for the sparks of static electricity that jumped from the cylinder to the metal concaves, igniting the dust in suspension and causing the explosion. The installation of a suction fan on the deck or top of the threshing machine and the application of ground wires for the removal of static charges prevented further explosions. It was an indication of how the results of scientific research could be applied to prevent losses of agricultural products during threshing operations.

We can go still further and point to the fine progress made by representative food industries in the reduction of losses from dust explosions. In fact, the investigations on dust explosion prevention in industrial plants now being conducted by the Federal Department of Agriculture were brought about by the interest manifested by grain millers of the country, more particularly of western New York, following the disastrous explosion at the Husted Milling Company plant in Buffalo in 1913. The Millers' Committee, consisting of L. E. Harmon, then President of the Buffalo Cereal Company; F. F. Henry, Manager of the Washburn-Crosby Company; and George P. Urban, of the Urban Milling Company, made it possible for the Federal Government to co-operate with the grain-milling industries in a thorough study of the causes of dust explosions in industrial plants, with a view to the development of methods of prevention. The active interest manifested by the Millers' Committee and the early provisions made by them for conducting both the necessary engineering and chemical research investigations have been of inestimable value to all American industries.

The food industries, where dust explosions were very frequent, have made practical application of the results of the scientific research work on dust explosion prevention. As a result there

has been a marked reduction in losses from dust explosions in these industries during the five-year period from 1930 to 1934, inclusive. In flour mills, for example, there have been only five explosions during that period. One man was killed and ten were injured, and the total property loss reported as the result of the explosions and the fires which followed amounted to 131,600 dollars.

In starch and corn products plants, where heavy losses of life and property have occurred as the result of dust explosions, only two explosions were reported during the last five-year period. In one of these cases there were no fatalities or injuries and practically no property damage. In the other case, six lives were lost and ten employees were injured, and a property loss of 7500 dollars was incurred. This explosion took place on September 20, 1930, and an explosion involving loss of life in a starch factory has not occurred since that time. This remarkable record for the starch and corn products industry is a significant indication of the value of the work of the safety organizations in this industry.

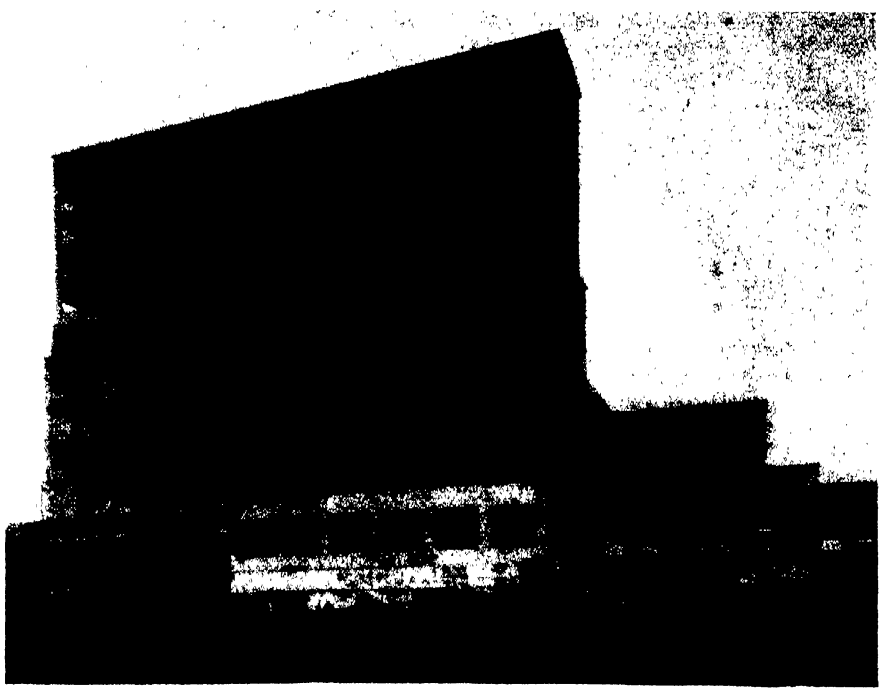
THE sugar industry also had a remarkable record during this five-year period. The last recorded ignition of sugar dust occurred in a pulverizer on January 31, 1930. Not a life has been lost in an explosion of sugar dust since June 13, 1917.

Only one explosion occurred in a cocoa and chocolate plant during this period. That explosion resulted in the loss of three lives, injuries to three others, and property damage of about 15,000 dollars. Not one explosion has occurred in connection with the grinding of coffee or spice during the five-year period.

The significance of the reduction of dust explosion losses in this group of food industries can be more fully appreciated when we realize that in this same five-year period under consideration (1930-1934) a total of 105 dust explosions in industrial plants have been reported, resulting in a loss of 61 lives, injuries to 190 others, and property damage of 5,038,160 dollars.

While the losses from dust explosions in the principal food industries have decreased, 39 grain elevator explosions were reported from 1930 to 1934. In these explosions 26 people were killed, 87 were injured, and the property losses amounted to 3,481,930 dollars. These 39 explosions in grain elevators were more than 34 percent of the total number of 114 explosions on record. These dust explosions in grain elevators show that more definite attention must be given to the application of methods for the control and prevention of dust explosions in these plants.

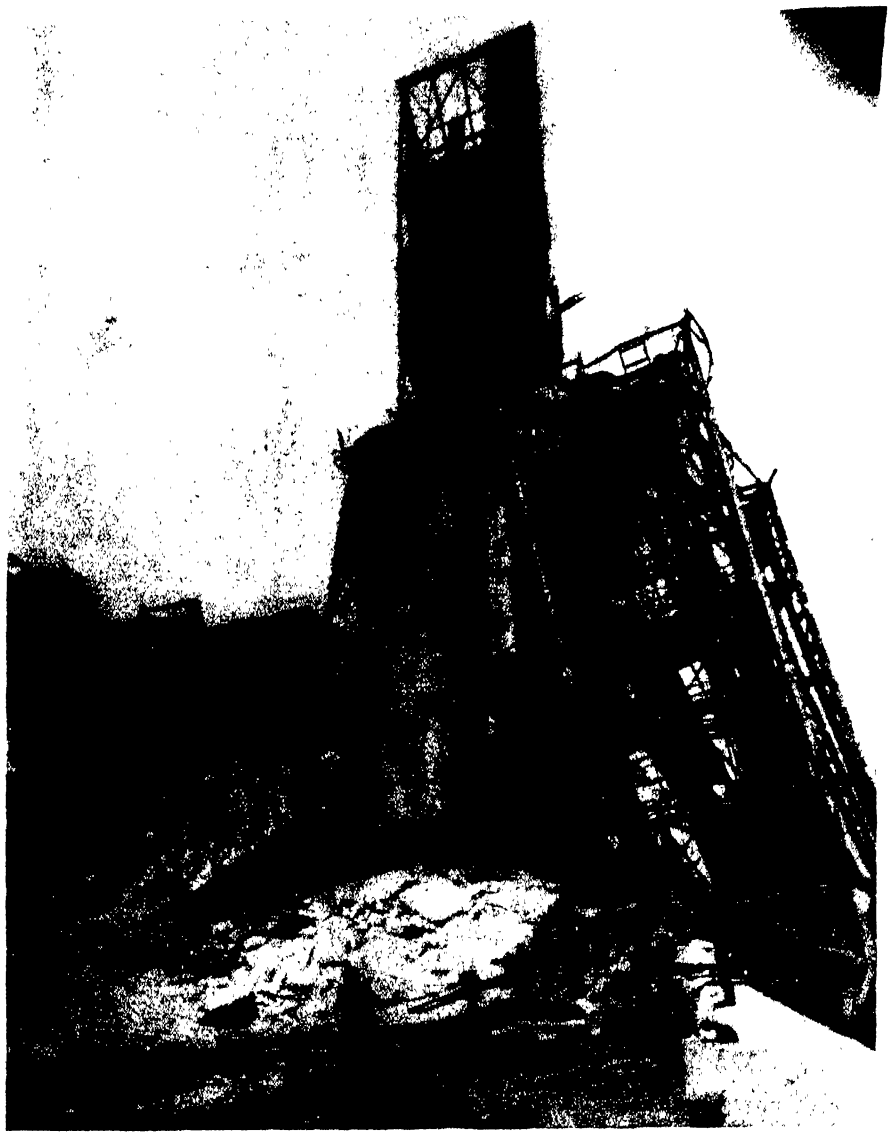
Above: **An experimental dust explosion in the testing station at Arlington, Virginia. Note flying glass. Adequate venting area has prevented damage to the structure.** *Below:* **A modern grain elevator showing application of glass vents**



Progress in the control of dust explosions in industrial plants is based on our knowledge of the causes of these explosions. The research work in the Bureau of Chemistry and Soils of the United States Department of Agriculture has shown that lighted matches, open flames, electric and metallic sparks, and similar sources will readily ignite explosive mixtures of dust and air.

With an understanding of the causes of dust explosions, it is possible to apply effective methods for their prevention. A dust explosion cannot occur unless combustible dust is present. For this reason cleanliness, or good housekeeping in the plant, is, after all, about the easiest and most effective method for preventing dust explosions. Suction systems are helpful in catching the dust particles at their points of origin and removing them. Of course it is equally important to remove all possible sources of ignition. All open flames, electrical apparatus likely to produce sparks, cutting or welding torches, and other heating devices should be eliminated from sections of an industrial plant where explosive dust is present. This will greatly reduce the dust explosion hazard.

Explosions have occurred from the breaking of incandescent lamp bulbs in dust clouds. Electric light bulbs should be provided with double globes and



The damage that can be caused by a dust explosion is shown by the remains of this terminal grain elevator. Six lives were lost in this disastrous explosion

outer guards to prevent breakage. It is important to prevent the accumulation of static electricity on machines to avoid ignition of the dust by static sparks. Special care should also be exercised to prevent hot bearings, friction of belts, and moving machinery from causing a fire or an explosion. A dust explosion can "force" its way out of the building. The opening through which the explosion is released, whether it be a swinging door, a window sash, or a break in a concrete wall, is commonly referred to as an explosion "vent." This word vent must not be confused with ventilation systems.

In order to devise ways and means for letting a dust explosion escape from an industrial plant without damage, the chemical engineers in the United States Department of Agriculture have erected a special dust explosion testing station at Arlington, Virginia. Dust explosions are staged "to order" and, as the result of this experimental work, a new protective measure has been developed for the control of dust explosions. This method consists of automatic or self-opening windows designed to release the dust explosion pressure in the plant before serious damage can be done to the building. The practical value of these vents has been shown in dust explosions in grain-handling plants, particularly in grain elevators.

THE effectiveness of glass vents as a means of explosion control has confirmed the results of the tests by the Chemical Engineering Division of the Bureau of Chemistry and Soils. Hylton R. Brown and Richard L. Hanson, the engineers in charge of the tests, recommend that for satisfactory venting of dust explosions in grain elevators not less than 1.25 square feet of venting area be provided for each 100 cubic feet of space, or one square foot to 80 cubic feet. For proper venting of starch dust explosions at least three square feet for each 100 cubic feet of space should be provided.

Sometimes the question is asked: How can the results of technical and scientific research studies be applied in such a manner as to be of real practical value? A fine example of this application is the splendid work done by the Dust Explosion Hazards Committee of the National Fire Protection Association. This committee, composed of representatives of industrial companies, insurance organizations, fire prevention and safety associations, State and Federal bodies, and other agencies interested in dust explosion prevention, has formulated a number of safety codes for the principal industries subject to the dust explosion hazard. These codes embody the results of the experimental research work of the Bureau of Chemistry and Soils, and this committee affords a very practical means of putting into actual plant practice the prevention methods that have proved effective.

THIS committee, since its organization in 1922, has developed safety codes for dust explosion prevention in the following industries: Flour and feed mills; sugar and cocoa pulverizing systems; pulverized fuel establishments; terminal grain elevators; starch factories; coal pneumatic cleaning plants; wood flour manufacturing establishments; spice-grinding plants; woodworking plants; and a code for inert gas systems for fire and explosion prevention developed in co-operation with the N.F.P.A. Committee on Manufacturing Risks and Special Hazards.

All these safety codes have been adopted by the National Fire Protection Association and the National Board of Fire Underwriters, and have been approved as "American Standard" by the American Standards Association. They have been published by the Bureau of Labor Statistics of the United States Department of Labor in Bulletin No. 562 entitled "Safety Codes for the Prevention of Dust Explosions."

Although we are making progress in controlling dust explosions, all the causes of these explosions are far from being fully explored. Dust explosions may occur in any plant as a result of some newly developed process, or they may follow the installation of some new types of mechanical or electrical equipment. Many explosions in industrial plants have been directly associated with the introduction of new manufacturing processes which have provided additional sources of ignition, and therefore resulted in conditions favorable to explosions. The expansion of large-scale industrial operations and the utilization of by-products and waste materials have greatly increased the hazards from dust explosions. Research studies on dust explosions in industrial plants are directed toward the saving of human life, property, and foodstuffs. They will result in measures for protecting employees in our industrial plants from disastrous explosions and resulting fires.

SECTION SLICER

Aids Study of Wool, Hair, and Other Fibers

Sample of hair in thin metal slot of the new device ready to be cut

AN invention which promises to be of great value in the manufacture of textiles, to the fur industry, to several branches of agriculture, and possibly in the detection of crime, has been announced by the United States Department of Agriculture. Invented by Dr. J. I. Hardy, senior fiber technologist of the Bureau of Animal Industry, a small mechanical device makes possible the rapid cross sectioning and clear study of the structure of hair, wool, mohair, fur, silk, cotton, and other fibers, both natural and artificial. Former methods of study involved laborious laboratory procedures and the results were often disappointing.

With this simple new slicer very thin cross sections can be prepared ready for examination within 10 minutes, whereas in the past it required several hours to obtain them. The new device makes it possible to cut them to one ten-thousandth of an inch without injury to the delicate internal structure. Moreover, such thin cross sections, even of seemingly opaque fibers, are sufficiently transparent for microscopic study.

Doctor Hardy has applied for a public patent on the device, which is about three inches in length and consists of three metal parts. A thin piece of metal contains a slot 0.0085 of an inch wide. A second thin flat piece of metal slides parallel to the first and pushes a short metal guide down the slot, pressing the fibers tightly together in a vertical position. The third part contains a small metal plunger on the end of a supporting screw for pushing the fibers ever so slightly through the slot.

After the fibers are inserted in the slot and secured firmly in it, they are cut off on both sides of the holder with a safety razor blade. The plunger is then swung into place and used to push the fibers from one side to the other according to the thickness of the cross section desired. A drop of liquid Celluloid is put on the projecting ends which are then sliced off with the blade. The Celluloid solution dries quickly without soaking into the fibers. The thin Celluloid slice carrying the tiny disks of fibers is then ready to be mounted on the microscope slide.

IN contrast to former methods, which involved the laborious work of embedding material in paraffin and difficulty in aligning the fibers, Dr. Hardy's device holds hair and other fibers firmly without crushing and keeps them in proper alignment for accurate cross sectioning.

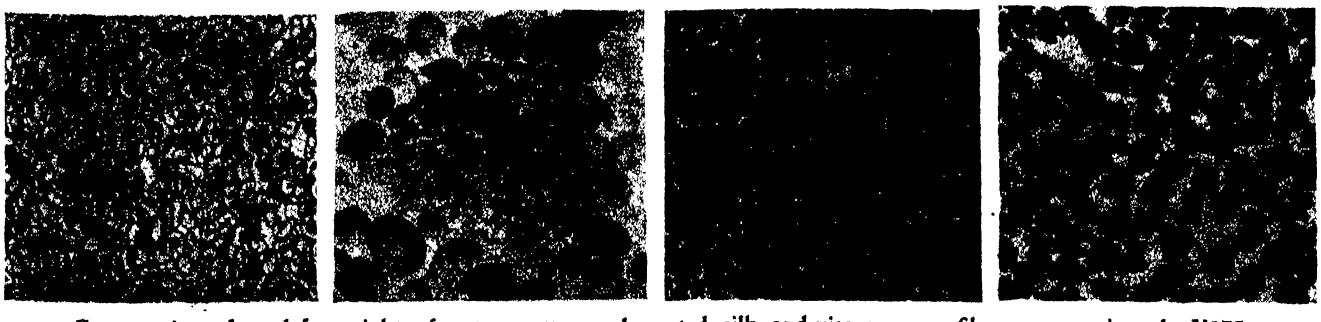
Information on the types of hair and fibers in various furs, fabrics, and industrial products can be supplied quickly and accurately through the use of the device. It promises to be especially valu-

Forcing out a small part of fiber, about 2.5 microns thick, for slicing

able in detecting questionable or fraudulent practices or misrepresentation of quality.

Use of the device should be valuable in livestock breeding, Department specialists assert, by aiding stockmen in the development of animals with a hair, wool, mohair, etc., of a kind in greatest demand in industry. The device should facilitate the study of cotton and other plant fibers. It is believed to have far-reaching possibilities also in the detection of crime. With the device it is possible to examine closely and quickly the cross-section characteristics of a tuft of clothing fibers such as a burglar might leave behind on a nail or splinter. Experts, by comparing the cross-sectional appearance of the fibers with that of a sample from a suspect's clothing, might find evidence to link him with the crime that had been committed.

The cross sections may be studied directly through a microscope or by making photomicrographs which may be filed away for further reference or sent to any part of the world for comparative study.



Cross sections, from left to right, of cotton, cotton and worsted, silk, and viscose rayon fibers—approximately X175

MORE ABOUT NOVA HERCULIS

Transformation of a Stellar Atmosphere into an Expanding Nebula . . . Outer Layers Blown into Space . . . Energized by a Hot Neighboring Star

By HENRY NORRIS RUSSELL Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society.

IT is nearly a year since the great new star in Hercules appeared, and it is again getting low in the evening sky —which makes it reasonable to review what has so far been learned about it. No other star has ever been so well observed. Its fortunate position, nearly 80 degrees north of the ecliptic, made it easily observable, both after sunset and before sunrise, even when it was in conjunction with the sun, and a star farther south would have been lost in daylight. Its great brightness permitted the use of the most powerful instruments, especially of the great spectroscopes which reveal such a wealth of detail, and which had not been constructed when the last bright nova appeared 16 years earlier.

Moreover, the changes in this star have been relatively slow, so that the inevitable interruptions of observation by bad weather and so on have left less serious gaps in the record. The mass of data which has been gathered by the united efforts of the world's observers is so great that its full utilization will occupy years to come: but a good general account of what was observed may already be given, and an explanation in general terms is possible.

WHEN Mr. Prentice, the English amateur, first saw the star on the morning of December 13th, 1934, it was of the third magnitude. It decreased by half a magnitude, and then brightened until, on the 23rd, it was of magnitude 1.5—equal to Alpha Cygni, and one of the most conspicuous stars in the sky.

For three months after this it fluctuated irregularly in brightness, with a slow general downward trend; then on April 1 began a precipitate drop which took it from magnitude 4.5 to 10 in nine days. A steady, though slower decline took it almost to the 13th magnitude in a fortnight more, and it might have been supposed that it would soon vanish altogether. But, early in May, began a steady rise in brightness, which brought it back to the 8th magnitude by the end of June. Since then it has varied but little.

To complete the record of the light changes, the "Harvard Library" of celestial photographs showed that the star had been visible for the past 40 years as a very faint object of magnitude 14.6. A month before the great outburst it was still faint. What happened in the meantime we shall never know, for Hercules had got so far down in the evening sky that it was out of range of the nightly "patrol" cameras.

Reduced to ordinary language, this means that the star shot up in less than a month, and probably in a much shorter time, to 50,000 times its original brightness. Ten days later, its light had increased to nearly 200,000 of the same units. It took more than three months to drop to 10,000; then, in hardly more than three weeks it went down to five times its original light: but it is now 200 times brighter than this.

Next in order (keeping together the observations which were made directly, rather than with the spectroscope) it should be recorded that, on July 1st, Kuiper, at the Lick Observatory, observed the star to be a close double. The components were 0.″21 apart, differed little in brightness, and were quite stellar in appearance—even sharper than ordinary stars. Later observations with other large telescopes have fully confirmed this, and show very little evidence of change.

Remarkable as these things are, not one of them is without precedent. Nova Aurigae, of 1892, faded away and came back, to remain visible for months. Nova Pictoris (1925) also remained bright for months (though without a second appearance) and while beginning to fade appeared to be divided into three or four components—too close, alas, to be clearly resolved with the most powerful telescopes available in the southern hemisphere.

To interpret these facts would be an almost hopeless task, were it not for the aid of the spectroscope—and here we have an abundance of new and important detail. When first observed, within a few hours after its discovery, the nova showed a spectrum of the type which we have learned to expect from these stars. Superposed on the ordinary continuous spectrum were wide bright bands, extending far on each side of the usual positions of the lines of the elements (such as hydrogen) to which they apparently belonged, and numerous dark lines, much narrower than the others, though not sharp, and displaced strongly to the violet.

Before going on with the tale it will pay us to recall the simple explanation of this type of spectrum suggested by Adams and fully confirmed by his observations of Nova Aquilae in 1919. Suppose that, in the first paroxysm, the star throws off the outer skin with high velocity—so great that all the force of its attraction cannot bring it back. An expanding shell of gas will then surround the intensely hot central core.

THE first observations of the present nova appear to represent a stage where this shell had already become thin enough to be fairly transparent and give out a spectrum consisting of bright lines.

The gas on the far side of the shell was receding from us: even the bright lines which it emitted appear to be shifted toward the red. The nearer part is approaching, and its lines are shifted toward the violet. The intermediate regions on each side of the star are moving crosswise and give lines in the normal position. As every intermediate between these extremes exists, the observed bright lines will be wide smears, extending far on each side of the normal positions. Right in front of the central star, however, this shell is in a position to absorb its light, and will give dark lines. But this part is coming toward us at maximum speed, and so all the dark lines will be strongly shifted toward the violet.

We need only recall briefly here how the expanding shell surrounding Nova Aquilae finally became large enough to be distinctly visible with large telescopes as a nebula surrounding the star, and still expanding year by year.

In Nova Herculis, the rate of expansion of the shell, measured by the shift of the absorption lines, was 250 kilometers per second on December 15th, and dropped to 180 in less than three days. This might naturally be attributed

to the attraction of the central star, pulling the ejected matter back, though not strong enough to keep it from escaping. Calculation shows that if the star's mass was a little larger than the sun's such an effect might actually be produced, while the shell was expanding to a radius of 40 or 50 million miles. As it grew larger the attraction became weaker, and would produce little future change.

As the star rose to its main maximum of brightness the bright bands faded out and a new set of dark lines, displaced much more than the others, made their appearance. This suggests that a second paroxysm had expelled another mass of material from the star, at a higher speed than the first.

The original set of dark lines persisted, since the outer, more slowly moving shell was still there: but the wide bright lines were swallowed up by the internal intensity of the general continuous background.

After a few days, the first set of dark lines disappeared. It is tempting to think that the faster-moving inner shell reached the outer one and literally swept it up.

This second shell appears to have been a big affair. Its absorption lines persisted for three months, showing a gradually increasing shift, as if the gas was still being repelled by the star. This is puzzling, as, with their average speed of 320 kilometers per second, the ejected gases must have reached a distance of 500,000,000 miles in a month's time. The strongest lines—of hydrogen and calcium—showed several other components with larger displacement, suggesting that smaller masses of gas had been expelled with greater speeds—up to 1150 kilometers per second!

THE main shell, judging by its spectrum, was composed of much the usual material of a stellar atmosphere. The familiar metals—iron, calcium, titanium—were present, also hydrogen, oxygen and carbon. For a few days, just after maximum, the bands of hydrogen appeared strongly. This is the first evidence of the presence of compounds in such a case, and suggests that the flying mass of gas must have been of at least moderately high density at the time.

As the shell expanded, these bands soon disappeared, indicating that the lower density had led to the dissociation of the compound. As time went on, the green auroral line of oxygen, and the related pair in the red, made their appearance. These are forbidden lines, which are produced only when the gas is so rarefied that the separate atoms have a long free time between collisions with others; but they do not demand so very low a density as many other lines of this sort.

When the great drop in the star's brightness occurred, the absorption lines disappeared—probably because there was not a strong enough background for them to show upon. The bright lines, which had been visible for a long time past, remained. The resulting spectrum was full of bright lines of iron, both of the ordinary and the forbidden sort (coming from the ionized atoms). Once again, though very peculiar, it was not unprecedented.

The southern star Eta Carinae shows a similar spectrum, and has done so for many years. It is of great interest that, during the first half of the 20th Century, this was a very bright star, sometimes reaching the first magnitude. For the past 50 years it has been of the seventh but, from the little we know about it, it seems to have been rather like a nova, except for the very slow tempo of its changes, which required years when days are usual.

The bright lines in Nova Herculis, at this stage, were fairly sharp, and strongly displaced toward the violet, by an amount corresponding to the velocity of the nearer side of the main shell of gas. The hydrogen lines, and others at times, showed faint components shifted toward the red by the same amount. This apparently strange behavior may be simply accounted for by assuming that the nearer side of the shell was shining strongly, while, for some reason or other, the hinder side sent in but little light. As the brightness dropped to the great minimum, the familiar lines characteristic of gaseous nebulae made their appearance; and the subsequent increase of light came almost entirely from this part of the spectrum. These are strongly "forbidden" lines, whose production demands that the atoms shall have long undisturbed intervals in which to emit them, and hence that their density shall be very low. As the nebular lines (due to oxygen atoms minus two electrons) strengthened, the auroral line (due to oxygen atoms with all their electrons on) weakened, so that the process of electron-stripping could almost be seen.

The whole process of transformation of a stellar atmosphere into a nebula has therefore again been followed, and more completely than in previous novae. In the present case, the ejected gases evidently did not form a nearly uniform shell, as in Nova Aquilae, but were distributed in irregular patches. The spectroscope showed (as has already been told) that the brightest patches were on our side of the star: the telescope has revealed two separate patches, and (if the whole thing does not fade out) may in time show more detail.

When the expanding shell is fairly uniform, a very good determination of the distance of the nova can be made by comparing its apparent size, measured at the telescope, with its real diameter in miles, found from the spectroscopic velocities. With such an irregular affair as this one, the method fails. Probably the best indication of distance is found in the strength of the "interstellar" lines, which show no trace of the rapid motions present in the star and its envelopes, but are absorbed by scattered atoms distributed thinly throughout interstellar space. In this way, a preliminary estimate of about 1200 light-years distance has been made; but other investigators find a somewhat larger distance.

ASSUMING 1500 light years, we find that, before its outbreak, the nova was about a quarter as bright as the sun (photographically); at maximum, some 40,000 times as bright; at its deep minimum a little brighter than the sun; and, when it appeared to have turned into a nebula, it gave out more than 200 times the sun's light.

Now an isolated mass of very rarefied gas cannot (in any known way) produce within itself such a flood of energy. It must act as a transformer, receiving energy from some other source, and converting it into visible light. For the original source, we must look to an excessively hot star in the near neighborhood—in this case, obviously the one from which the gas was ejected. The second rise in brightness must have resulted from an enormous emission of ultra-violet light from this star—very likely much more than was transformed into visible radiation in the patches of nebulosity outside.

What happened to the central star we can only conjecture, but, to give out so much ultra-violet, and so little visible light, its surface must have been intensely hot—perhaps at a temperature of 50,000 degrees or more. Had it remained of the same size as before the catastrophe—when we very reasonably guess that it was a bit smaller than the sun—it would have shone brilliantly. However, it is highly probable that, while the gas-masses were driven off, the central body shrank to a small fraction of its original size. There is good reason to believe that, nevertheless, only a small fraction of the total mass was expelled, and that the surviving nucleus has become a dense body like a white dwarf. All this supports a suggestion of Milne's, that, under certain conditions, the interior of a star may become unstable. The main mass may suddenly contract to a small size, heating itself excessively, but the outer layers, blown away into space, form the expanding nebula. But we must know more about atoms, and how energy is normally furnished to keep the stars shining, before such a hypothesis can be fully tested.—*Mount Wilson Observatory, November 30, 1935.*

THE HEEL OF THE CONQUEROR

Ancient City Mound in Palestine . . . Evidences of Several Conquests Revealed to Excavators

By JOTHAM JOHNSON
University Museum, Philadelphia

FROM the Sea of Galilee the valley of the Jordan drops steadily toward the Dead Sea. Fifteen miles below its source a lateral valley cuts into it from the west, drained by the swift Jalud and dominated by three ancient caravan cities, Megiddo, Esdrael or Jezreel, and Beth-shan (Figure 1).

Town-names are many in a land so often overrun by amateur linguists. Just as Galilee is known as Chinnereth, Gennesaret, and Tiberias, and Megiddo becomes Maximianopolis and Armageddon at a speaker's whim, so Beth-shan became Ba-ti-san to the Egyptians and Bit-Sani in the Amarna letters. Today the nearby Arab town is Beisan; the inhabitants call the ancient mound Tell el-Hosn. The Greeks dodged the issue entirely; they called it Skythopolis, and Nysa. Bashan ('the Bull of Bashan') is different; it is a cattle-raising district in Transjordan.

Old Stone Age men were hunters. Heedless of the dramatic events destined there for future centuries, they ignored the low natural mound (Beth-shan) which rose from the south bank of the Jalud, four miles above the Jordan. But Neolithic men were farmers who required rich soil and copious water for their poor seed. They thought the mound ideal, and long before 3000 B.C. they built a little village there, the most primitive yet excavated in Palestine, in order to be near their fields. Their houses were squalid pits dug three or four feet deep in the damp red soil, roofed with matting or brushwood. Their tools were of flint; their pottery was crudely made by hand, and some of the bowls were decorated with red paint. To find them we have sunk a great shaft through the mound (Figure 2), from the floor of Level IX through nine earlier strata (Figure 3).

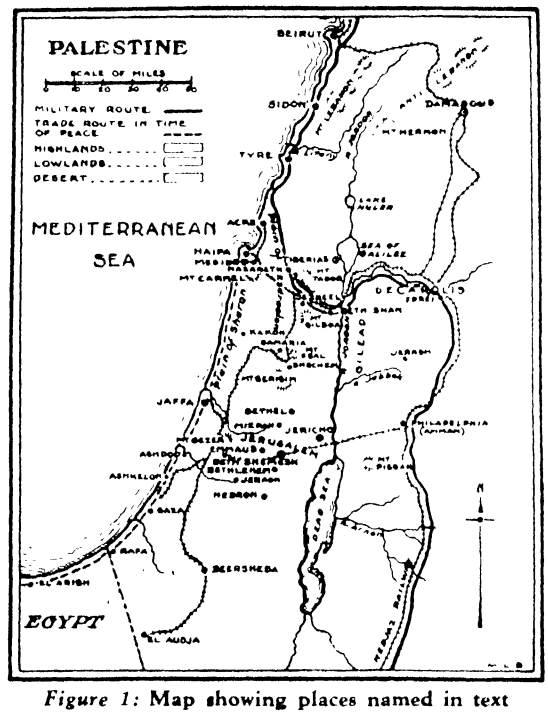


Figure 1: Map showing places named in text

Presently, invaders superseded the pit-dwellers. We have learned that they introduced copper at Beth-shan and built real houses of sun-baked brick; this is Level XVIII, the oldest of nine Bronze Age cultures before Palestine's destinies became merged with those of Egypt. Life in northern Palestine was peaceful throughout this time; the country was inhabited by Canaanites, distant kinfolk of the Israelites, speaking a dialect of Aramaic also spoken by the Habiru; eventually it was known as Hebrew. None of the early levels was closed over by the blanket of ashes that at many ancient sites tells bluntly of the invader's torch, and none was defended by city walls.

PALESTINE was made to be conquered. In the early 17th Century before Christ the bustling market-towns and the sleepy agricultural communities were quietly subjugated by a mysterious Asiatic people, the illiterate Hyksos, known

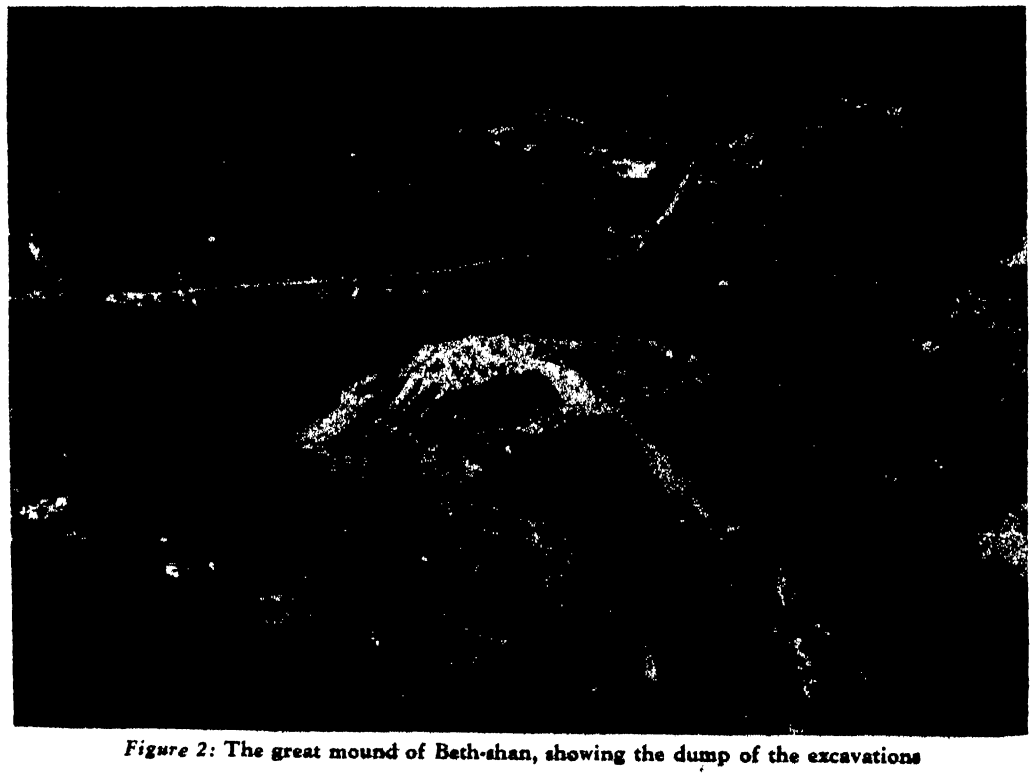


Figure 2: The great mound of Beth-shan, showing the dump of the excavations

to archeologists only by the disparaging comments of their unwilling hosts and by a few potsherds of rare type.

Unimpressed by the might of the Pharaohs, the Hyksos presently wrote themselves into history by forging into Egypt, which they captured in 1675 B.C. A century later Ahmose I drove them back across Suez, and his successors' repeated raids into Palestine weakened and disheartened them. In 1479 B.C. the last remnant of their union with the Syrians and Canaanites was wiped out by one of Egypt's greatest kings, Tuthmosis III (alias Thothmes), in the famous battle of Megiddo.

Tuthmosis took over their captured provinces, and Beth-shan appears on the walls of the Karnak temples on the boastful lists of towns he won. Off the record he might have admitted the true motives of his conquest: to guard against a reawakening of the sore and smarting Hyksos, or against an invasion by that newly-risen northern power, the Hittites, to secure spoil and tribute, and to tax the profitable commerce of the age-old caravan trails; but if he had felt called upon to justify his conduct in public he would surely have declared it his divine mission to enlighten these miserably backward peoples. Ancient history is not bunk; it is merely the school of dictators.

CERTAIN it is that under Tuthmosis the ninth level was built and Beth-shan's prosperity began. The excavations of the University Museum, begun in 1921 under C. S. Fisher and later directed by Alan Rowe and by G. M. Fitzgerald, have revealed a vast temple, divided into two sanctuaries (Figure 4). In the southern part lay an inscription recording its dedication to Mekal, the local Baal; the northern sanctuary we think was built for Antit who as Ashtoreth, Astarte or Ishtar was known to the furthest limits of the ancient world.

BETH-SHAN

Level	I	Arabic	636 A. D. to modern times
	II	Byzantine	330 A. D. to 636 A. D.
Iron	III	Roman Jewish Hellenistic Greek	301 B. C. to 329 A. D.
		Mound deserted	*c. 1000 B. C. to 301 B. C.*
Age	IV	Israelite Philistine	c. 1150 B. C. to c. 1000 B. C.
	V	Egyptian (Rameses III)	1198 B. C. to c. 1150 B. C.
Late	VI	Egyptian (Seti I and Rameses II)	1313 B. C. to 1198 B. C.
Bronze	VII	Egyptian (Amenophis III)	1411 B. C. to 1314 B. C.
	VIII	Canaanite peasants	1447 B. C. to 1412 B. C.
Age	IX	Egyptian (XVIII dynasty; Tuthmosis III)	1479 B. C. to 1447 B. C.
Middle and Early Bronze Ages	X to XVIII	Canaanites and others	
Neolithic	and Pits		

Figure 3: A table of levels or strata in the mound. Read from the bottom up

In the temple stood several altars, one provided with a channel for draining off the blood; beside it lay a ritual dagger of bronze and the bones of a young bull, the last animal to be sacrificed before the temple was destroyed.

The temple, dedicated to Canaanite gods, is thoroughly a product of local architecture; plan and materials alike conform to local prejudices to make this the finest as well as the earliest example of Canaanite public architecture yet discovered. Only for details—cornices, door-mouldings, column capitals and bases, stepped altars—did the builders rely on Egyptian inspiration, no doubt because optional decorations were unknown to the native art.

Just outside the temple the excavators came upon a bas-relief in basalt (Figure 5). The upper scene shows a fight between a lion and a dog; in the lower the lion's tail is between his legs, and we judge him to be in retreat, however stiff and dignified. As he goes, the dog slavers at his back. This inaccurate sculpture has vigor and a lucid symbolism, if we identify the dog as guardian of the temple and the lion as Nergal, god of pestilence and death; the guardian has driven plague from the communicants. You will find it one of the proudest possessions of the new museum in Jerusalem.

Figure 5: A bas-relief in basalt

Figure 4: The temple excavated in Level IX, where ancient rites took place

Also in Level IX was found broken pottery from Cyprus and Crete. It is with some apprehension, nowadays, that we turn up Mediterranean wares in such closely-dated strata, because the life-work of a hundred scholars who have synchronized Aegean pottery with that of Asia Minor and Egypt might be wiped out by a new stratification; the Beth-shan types happily agree with the dates expected of them.

This much we know about Beth-shan under Tuthmosis' rule, because we have

seen the evidence resurrected from its long burial. To digress a moment, we may borrow further details from the pages of general history.

The community living isolated from the trading world, producing all its own goods without surplus, has never existed except in the imaginations of economic theorists. Fifty thousand years back, paleolithic man must have bartered the

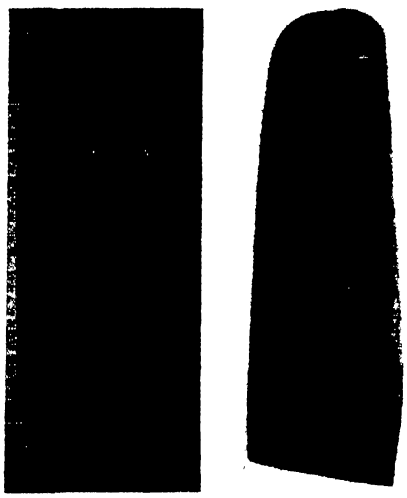


Figure 6: **Two stelae found in the 6th Level of the Beth-shan mound**

chestnuts of the hills against the salt of the coastal flats. At Tepe Gawra (Articles on Tepe Gawra appeared in Scientific American, Oct., 1935, pages 178-179 and Dec., 1935, pages 310-313. It does not appear on the map, Figure 1, being 500 miles northeast.—*Ed.*), closer to the elements than any other organized community which we can study in detail, gold, copper, lapis lazuli and carnelian are found (and these merely head the list), none of them produced locally and some imported from great distances. As soon as one Tepe Gawran raised a few extra bushels of grain, to trade for a gem for his fiancée, the rest were sure to follow suit next year. The story of civilization can be followed in the rise of man's appetite for luxuries, spices and perfumes, rare cloths and precious stones.

The big towns of the interior, Aleppo, Hama, Homs, Palmyra, Damascus (the most admired if not the oldest of all), Beth-shan, Amman and Petra were—most of them still are—natural foci; Beth-shan, for example, received much of the traffic south-bound from Damascus for Jerusalem and beyond to Egypt and return, and a large share of the products of the Transjordan desert fringe, bound west to the coast. On this commerce the government exacted as many taxes as possible—one of the reasons why the Egyptians wanted Beth-shan; and the caravan track was a military route as well. In return the government was supposed to police the desert trails and to keep the water-holes open and clean. It rarely did.

The heel of the conqueror seldom trod too heavily, however; these imposts might bite deep into the profits of the middlemen, but it could have made little difference to them or to the farmers if the yearly tribute in precious metal (by weight; coinage was yet to be introduced), labor or materials was paid to the local agent of distant Egypt's king or to some local sheikh, except that in the long run the stronger rule made for longer peace and more lasting prosperity. The modern argument that war will cure an economic crisis may yet prove fallacious. None the less, Palestine reserved the right to revolt at every opportunity.

Archeology brings home with deadly clarity the extent of Egyptian aims in Palestine. The Egyptians who manned the garrisons and customs-houses and law-courts, who erected stone slabs with hieroglyphic messages and lost their scarabs in Beth-shan's dusty streets, were the lone representatives of the conquering power. Egypt was interested only in farming the land's taxes, and the whole provincial administration was designed to keep the tax-gatherers alive and active.

LEVEL IX was destroyed after a generation; we do not know how, by whom or why. Upon its ruins was built a rude mud village without temples or other public buildings. The finds are poor, too, although we are grateful for a little Mediterranean pottery, some cylinder seals, and a few Hittite objects, welcome to the diggers of Beth-shan as tell-tales of contact with the outer world.

With Level VII (Figure 3) Beth-shan became once more a great city. A new Canaanite temple was built, and beneath its altar steps were placed a scarab, a ring, and other objects bearing the name of Amenophis III who came to the throne in 1411 B.C. Near the temple were erected a fort-tower and a house which may have been the residence of the commandant, and a silo capable of holding a thousand bushels of grain.

In 1375 Amenophis died and was succeeded by his son Akhnaten, effeminate and mystic, husband of the charming queen Nefertiti. He was far too concerned in forcing Egypt's religion into the mold of his monotheism to care about the wider Empire, and through his and his glittering nephew Tutankhamun's reigns Palestine and Syria gradually dropped from Egyptian control until the time of Seti I who won them back and built a new Beth-shan, Level VI.

In the foundation deposits of his new temple we found the rings and scarabs of his father Rameses I and of himself, which he thoughtfully placed there. In the sanctuary he also set up a great stela of basalt (Figure 6, at left) engraved in hieroglyphics and dated in the year he began to reign, so that his first thought must have been to regain Egypt's lost Palestinian tributes. His successor, Rameses II, set up a second stela (Figure 6, at right) to commemorate his prowess in suppressing new revolts in Palestine; this stela has been brought to Philadelphia and erected in the University Museum. From this period date the curious pottery coffins whose lids resemble human features (Figure 7) made for mercenary soldiers of Mediterranean origin.

About 1350 B.C. arrived the first apostles of a new order. The Israelites crossed the Jordan some distance below Beth-shan and captured Jericho. Later they attacked Beth-shan, but were thrown out.

The fifth and last Egyptian level at Beth-shan was founded by Rameses III about 1195 B.C. Rameses had to fight the Philistines who pressed down from their spawning-grounds in the vague north and attacked Egypt; he drove them back, and defeated them in Palestine, but they remained to settle in the fertile coastal plain, and to give the country its name.

After his death in 1167 B.C. the mercenaries sold out to the Philistines. Beth-shan passed forever from Egyptian control, and became a stronghold of Philistine power. About 1020 B.C. they won a battle from the Israelites, led by Saul and his sons, on nearby Mt. Gilboa.

Figure 7: **The large pottery lid of a mercenary soldier's curious coffin**

Saul, defeated and wounded, killed himself, and his conquerors exhibited his body and his armor in public triumph at Beth-shan. A few years later David, or someone else, avenged this outrage and destroyed the town. It was not occupied as a city again until the Greeks of Alexander came in; from then on Beth-shan's history is the story of the Greek and Roman worlds.

PATENTS AND INDUSTRY

THE accompanying summation of a report submitted at the request of the Secretary of Commerce as a part of the Second Report of the President's Science Advisory Board, is important in that, if the recommendations should be adopted, the radical changes would tremendously affect not only the inventor holding a single patent and the corporation holding hundreds but also the general public which benefits by every new development. What the effect might be, we leave to the judgment of our readers. We present the recommendations embodied in the report, together with some of the advantages and disadvantages of each suggested change; and ask that, after careful study, you write us your opinion. Should you and other readers supply us with sufficient and convincing evidence of the general feeling regarding these recommendations, it is our plan to appear before official hearings and assist in clearing up any quirks which may be present. Please address your letter to The Editor.

"THE patent system of the United States was set up originally to benefit the public by advancing the useful arts. It does this by creating a temporary monopoly, thereby rendering possible the hazardous development of untried inventions, which would not otherwise come to fruition to add to the general well-being and increase the standard of living of the people. By its substantial rewards, it stimulates invention and the assiduous study and persistent effort on which invention is based. That it has been successful needs no demonstration, for its results are all about us."

This statement, together with further discussion anent technical advances which result in the creation of new and extensive industries for the well-being and prosperity of the country as a whole, comprises the introduction to the report of the Science Advisory Board's committee on the "Patent System and Stimulation of Industries." As the quotation indicates, the Committee was concerned in its study, not with any question of abandonment of the system, but with the development of "a broad policy and program for the stimulation of new industries in this country." Quoting further: "The inquiry is directed to the stimulation of new non-competitive industries, using 'non-competitive' in the sense that they should not merely replace an existing industry or product by a substitute of no greater social value; but rather should increase the potential aggregate of gainful employment, increase the comfort and safety of living, or confer other important social benefits."

Having explored the subject of patents fully, the committee recommended:

1. ". . . that, when an application is ready for allowance, it be published in the Official Gazette, and the submission of pertinent facts by interested parties invited."

2. ". . . that there be established a single Court for Patent Appeals, in order to establish and maintain harmony and accuracy in judicial interpretation of patent questions, by confining the appellate jurisdiction in civil patent causes to one court, composed of permanent judges having the necessary scientific or technical background."

3. ". . . that there be provided scientific or technical advisors or juries to furnish adequate scientific or technical assistance to courts of first instance in equity patent causes."

4. An annual tax upon all patents.

The argument of the committee on Recommendation No. 1 cites the complexity of our patent system with 90,000 patents issued in a year. This is an error, for the annual average for 1932, 1933, 1934, and 1935 has been substantially less than 50,000. Even so, without an increase in the corps of examiners, it is impossible to review adequately all prior art. French patents are issued with little or no examination while the British and German systems provide for publication of an application before issuance. Our patent system is better than the French, says the Committee, but a modification of the system to permit publication before issuance will increase the presumption of validity and tend to lower the probability of expensive litigation.

In favor of this may be cited the fact that the Patent Office does not have at this time adequate facilities for making a complete search with respect to any invention outside of the field of the patented art. The result is that patents are often granted for inventions which have been in use for many years but which for some reason or another have never been patented. Pre-publication would prevent such patents from issuing. Also, it would tend to remove from the Government the burden of making an adequate search and place it upon the persons whose interests are really affected, with the final result that the cost to the Government might be reduced.

One disadvantage of this scheme would be that large and unscrupulous organizations could effectually prevent the inventor from securing a patent on any important invention by simply opposing the grant of his patent and subjecting him to a greater expense than he could afford to pay in his efforts to secure his patent. Also, any departure from the present custom of the Patent Office to maintain applications in strict confidence, except in certain well defined cases, would lead to fraud. Persons other than the true inventor, having seen published accounts of a patent application, could make fraudulent application for a patent on the same invention.

The American Bar Association has rejected several times in recent years the suggestion (Recommendation 2) that a single court of patent appeals be established. The expense which would be incurred by litigants in travelling from all over the country to the location of the court seems to be the main objection to this scheme. Or, if this single court should move to various parts of the country, appeals could be argued only in specific periods in any particular locality, thus making for delay. Furthermore, it would set a precedent for the formation of other special courts of appeal to handle admiralty cases and other cases involving special branches of the law.

ONE strong argument in favor of this proposal is the fact that it would tend to produce uniformity of decisions in patent cases. There are 10 Circuit Courts of Appeal in the country and often there is a conflict in opinions between circuits, which opinions often cannot be made uniform because of the difficulty or expense of reaching the Supreme Court. It would also tend to create a court of experts over a period of years, both in patent law and various branches of science.

The Committee's Number 3 was based on the fact that patent litigation is concerned with both the law and the technical facts. No amount of evidence, voluminous though it may be, can quali-

(*Please turn to page* 109)

WHY DOES THE

Family Rows Rare Within the Atom . . . Peculiar Behavior of Electric Forces Prevents Nucleus From Flying Apart . . . Scientists Seek Solution

By JEAN HARRINGTON

THE worthy gentlemen who write dime-thrillers frequently amuse themselves by imagining what may happen "when somebody makes a machine to blow up atoms and let their energy loose." But scientists are not much troubled about such a possibility; they have, in fact, blown up many an atom already, with no dire results. What bothers them more is why the atom does not more often blow up by itself; why, indeed, it sticks together at all.

If the laws of the world of normal sizes held down in the region of atomic dimensions, there would be reason to expect that the pieces which join to form the core or nucleus of an atom would almost never approach each other closely, let alone stick permanently together, for under ordinary circumstances, electrical charges of like sign repel each other with a force which grows larger the nearer they come together. This is according to the classical electrostatic law which every student of elementary physics knows: The force between two charged bodies varies directly as the product of their charges and inversely as the square of their distance apart.

Thus, when two similarly charged particles touch or collide, the force tending to separate them should be infinitely great. But this cannot be actually the case, for within the nucleus of an atom dozens of positively charged protons may exist together in peace and harmony, with no tendency whatever to explode and fly off into space, except when tampered with from the outside.

HERE scientists are confronted with another phase of the same problem which faced Einstein before he presented the world with relativity. The classical mechanics of Newton, which for several centuries had dealt successfully with the more ordinary phenomena of earth and sky, were known to fail occasionally within the depths of the universe. Einstein took Newton's laws and extended them to fit a cosmic scale. Classical laws must now be adjusted again, to fit and to express the behavior of the infinitely small.

The Rutherford-Bohr nuclear atom has been the standard atomic model since Bohr's work in 1913. Naturally the nucleus is not its only part. It is the massive, positively charged core, around which sweep negative electrons in fixed orbits of various sizes. But our problem

Figure 1: **Heisenberg, the brilliant German physicist who originated the neutron-proton nuclear theory**

of atomic stability does not arise in connection with these extra-nuclear electrons. They seem to obey the laws of the universe better than their brother protons within the nucleus. They are held in their courses by the attraction of opposite charges, and there they stay, spinning and revolving, as stable as the solar system, and we may cease to worry about them. It is the nucleus which gives us trouble.

From studies of radioactive disintegration and from other experiments in breaking up atoms, it soon became apparent that protons, alpha particles, and perhaps electrons originate within the nucleus. How could these building blocks be stacked to fill the two chief requirements: atomic weight and atomic number?

Until the neutron was discovered in 1931, it appeared that the proton was the most important construction unit, both of weight and charge, for it forms the nucleus of the simplest and lightest element known, hydrogen. It was thought, for example, that the oxygen atom must contain 16 protons, for it has an atomic weight of 16. Its atomic number (that is, its positive electric charge) is only 8, so, in order to neutralize half the charge of the 16 protons, it was necessary to put eight additional electrons into the nucleus itself. Moreover, every four protons were supposed to combine with two electrons to form a kind of sub-unit of structure, the alpha particle.

This conception was very hard to swallow, for the electron, although it weighs far less than the proton, compares with it in size as a cathedral to a pea. How to get eight cathedrals into a pea-pod? This disgruntled the physicists no end. And here, again, was the question of stability. Why should the protons left without electron mates stick together as they did? Theoretically, they should still be repelling each other in opposite directions just as hard as ever before. This problem was shelved for the time by supposing that the electrons formed a kind of cement which held them all together.

THE appearance of the neutron on the atomic scene helped to clear things up. To all practical intents and purposes it has the same weight and size as the proton, and fits into the nuclear pea-pod much more comfortably than the electron. It has no electric charge at all, and thus its inclusion in a nucleus affects only the weight and not the atomic number. Now the oxygen nucleus becomes a huddle of eight protons and eight neutrons.

But in a breath, the convenient electron cement idea was swept away. Then it was that the scientists began to juggle with the laws of the universe. The inverse square law of repulsion between protons, they said, must fail at distances as tiny as these we are dealing with inside the nucleus. There must be another force acting, of nature unknown, but strong enough to hold the nucleus together.

Stick Together?

This force the German physicist Heisenberg (Figure 1) assumed to be a strong attraction between proton and neutron, and there are various and sundry reasons to justify the assumption. Foremost is the tendency for the formation of neutron-proton pairs within the nucleus. Long before the existence of either particle was known, it was noted that for most elements, and particularly the lighter ones, the atomic number was roughly half the atomic weight. The formation of pairs with a charge of 1 and a weight of 2 gives a plausible physical explanation of the phenomenon.

It is true that the heavy elements, such as lead and mercury, have a preponderance of neutrons in their nuclei, and this we will attempt to explain later. But it is also true that the most stable and most abundant elements are those which contain equal numbers of protons and neutrons. Thus silicon, with 14 pairs, and oxygen, with eight, together make up 75 per cent of the earth's crust, and are equally abundant in the stars.

The mathematical expression of the behavior of the nucleus is given by a curve (Figure 2), which, because of its shape, is known as the potential barrier. It shows how the strength of the electric forces varies within and around the nucleus. Along the horizontal line, the distances are marked off in trillionths (10^{-12}) of centimeters. Along the vertical axis, the electric force or potential is plotted in millions of electron volts. The zero point at the crossing of the axes represents the center of the nucleus.

What does the curve tell us? Suppose, for example, that we have a proton which we would like to shoot into the nucleus from the outside. As it approaches along the horizontal axis, it encounters a repelling force which grows stronger and stronger as the distance grows less. It is as if we were trying to roll a ball up a hill which grows steeper the higher we climb. This effect is shown by the rising portions of the curve, and it is just what we would expect from the classical electrostatic law.

But suddenly the curve stops going up and drops abruptly to zero and below. This phenomenon occurs at a point about one trillionth of a centimeter away from the center of the nucleus. If we have given our proton enough energy to overcome the growing force up to this point, it suddenly ceases to be repelled, and is attracted straight into the heart of the nucleus.

If, however, we have failed to shoot our projectile with enough force to scale the potential barrier, it will simply graze the nucleus and be repelled in another direction. Cloud chamber photographs of the tracks of such projectiles have been taken (Figure 3). We can control and measure the energy of the projectile, and we can measure on the photograph the angle through which it has been deflected; thus we can calculate the strength of the electric field which has given it the deflection. This is our chief clue to the shape of the potential barrier.

The existence of the pit in the middle of the curve, the so-called "potential hole," is very significant. It shows how the classical electrostatic law fails within the nucleus. It shows that some force other than electrostatic repulsion must exist to hold the particles together. And it shows that the strong electric field surrounding the nucleus, the potential barrier represented by the peaks of our curve, serves not only to keep other charged particles out, but to hold the protons within. If a proton coming from the outside needs six or seven million electron-volts of energy to cross the barrier and get inside, then a proton which is already inside needs the same amount of energy to leap over the barrier and escape.

But this is a statement which, as usual, when we are dealing with atoms, must be modified. Nowadays, according to wave mechanics, everything is based on the principle of probability. Because a body usually obeys a certain law no longer means that it always does. Our old laws are no longer absolute; they are expressions of *average* behavior.

We need to introduce this idea here to show that the potential barrier is not an absolute quantity. If we have a proton with a given amount of energy outside the nucleus, there is a certain probability that it will penetrate therein. The more energy it has, the better its chances of doing so; and if its energy is equal to that of the potential barrier, it is fairly certain of success. But the fact remains that a particle has a chance of getting into the nucleus, and conversely, of escaping from it, with an energy less than that represented by the potential barrier. Experiment shows that such a case frequently occurs.

It must be quite clear that the potential barrier applies only to charged particles, such as protons, alpha particles, or the bare nuclei of other elements. An electric field has no effect on an uncharged body; hence for neutrons there is no repulsion and no potential barrier to cross. They can penetrate quite easily into the nucleus; the fact that they are held there so tightly is so far unaccountable unless one accepts Heisenberg's theory of strong proton-neutron forces.

It must also be understood that the potential barrier is harder to cross for

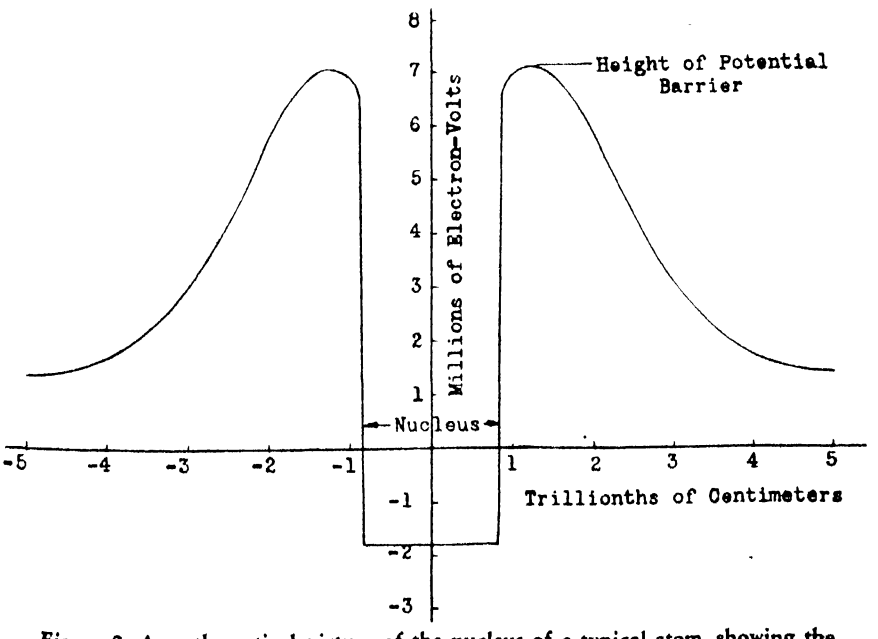


Figure 2: **A mathematical picture of the nucleus of a typical atom, showing the barrier of electric potential which surrounds the nucleus and holds it together**

some particles than for others. A proton, for example, experiences less repulsion from a nucleus than an alpha particle with its double charge. The latter must have more energy than the proton in order to penetrate a given nucleus. A further complication is that the barrier annoyingly changes height whenever a charged particle is added or subtracted; for obviously a change in the concentration of electricity within the nucleus alters the strength of the field around it.

Illustrating, as it does, by a sudden drop from positive to negative potential, the attractive forces operating within the nucleus, the potential barrier answers the question of why the atom sticks together at all. It does not explain how the nucleus is actually composed, nor the nature, the cause, and the behavior of the forces holding it together: these are still matters of conjecture—problems ready and waiting for the Einstein of the atom.

But there is still another check on our belief that, whatever their nature, the forces within the nucleus are real and tangible. The check is the odd fact that the nucleus always weighs less than the sum of its parts. If, for example, we add up the free weights of two protons and two neutrons, we should, theoretically, get the weight of an alpha particle. Actually, the alpha particle weighs slightly less than this total. What has happened?

THE solution of the mystery lies in the fact that mass and energy are in reality two different forms of the same thing. Mass can be changed into energy, and conversely, energy can be transformed into mass. Energy was needed to bring the particles together and hold them there, and so some of their mass obligingly transformed itself, and was used up in the process of forming the nucleus. If we should ever wish to restore the particles to their original mass we must give them back the same amount of energy that was transformed from mass into the cementing forces.

All nuclei have undergone a loss of mass, some more than others. The difference between the theoretical and the actual weight is called the mass defect, and it represents in every case an equivalent energy loss, which is known as the binding energy. A nucleus which has a high binding energy relative to its weight is more stable than one of low binding energy. This is the first factor in our last problem, of why some nuclei stick together so much better than others.

An unstable nucleus is one in which the forces trying to preserve its unity are in some way unbalanced. The balance of forces depends upon the ratio of neutrons to protons, and this in turn is dependent upon the energy levels within the nucleus.

The idea of energy levels is a familiar one, for the electrons revolving outside the nucleus have long been known to possess only certain fixed amounts of energy, represented by the size of their orbits, or, in more up-to-date terms, by their wave lengths. But that levels also occur within the nucleus is a fact only recently acknowledged. A study of the velocity of alpha particles emitted from radioactive elements showed that they could be classed into various speed groups, indicating that they started from a series of different energy states within the nucleus itself. (These states, incidentally, give a further clue to the shape of the potential barrier.)

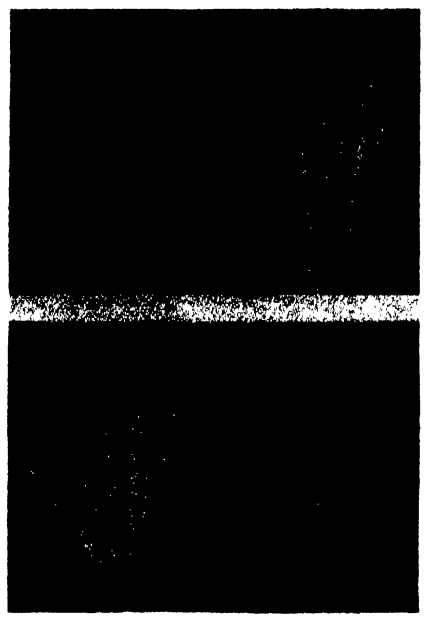


Figure 3: **Alpha particles deflected from their paths by passing through the electric fields of light nuclei. From such photographs the shape and size of the potential barrier can be determined for many elements**

This means that as each successive proton or neutron is added to the nucleus, it falls into a fixed energy state, the lowest one still unoccupied. There are two sets of levels, one for each kind of particle; for the proton, the levels are farther apart, to make room for the additional energy it has because of its electrical charge. We might compare them to two ladders, the proton ladder having rungs spaced wider than the neutron rungs.

For the nucleus to be stable, the topmost neutron and proton must be at approximately the same height on their respective ladders. As the elements increase in atomic weight, the proton gains in height on the neutron, and hence we must put extra neutrons on the upper rungs to catch up. Thus, in the heavy elements, there may be as many as 30 or 40 percent more neutrons than protons.

When the nucleus acquires too many neutrons or too many protons, the balance of forces between them is upset. It cannot stay as it is, and sooner or later it tries to right itself by shooting off some particle or other, and changing itself into a nucleus of a quite different kind.

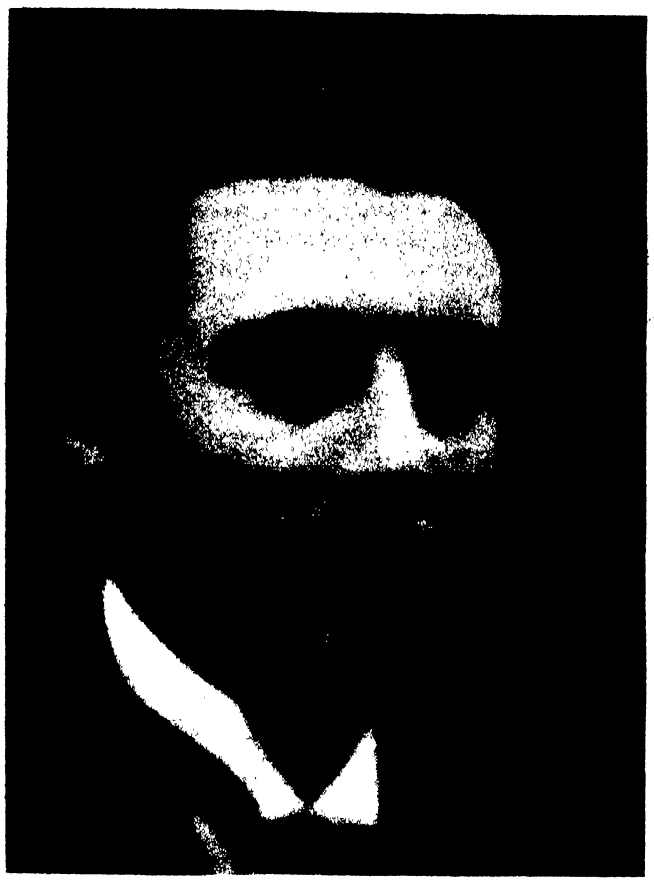
Strangely enough, it does not emit its extra protons or neutrons; not, at least, if the disintegration is spontaneous and unforced. It may give off an alpha particle, an electron, or a positron. But, you cry, then do all these things exist in the nucleus too? Probably not. It is more likely that they are created at the instant of emission.

An extra neutron, for instance, may split into a proton and an electron, the latter flying off into space as soon as it is created. This is a common type of disintegration among the unstable, radioactive elements. Similarly, a proton may change itself into a neutron by emitting a positron, the positive analogue of the electron. With the emission of an alpha particle, the nucleus rids itself of two neutrons and two protons at one fell swoop. Although it is still argued by some that the alpha particle must pre-exist in the nucleus, the present tendency is to consider that it, too, is created, as it were, on the wing.

IN the foregoing discussion we have tried to show how stability depends on the ratio of protons and neutrons present. For a given number of protons, there may be anywhere from two to nine possible neutron combinations without unbalancing the energy levels too radically. This accounts for chemical isotopes, elements which have the same atomic number and identical chemical properties but differ in the weight of their nuclei. The most abundant and the most stable isotopes, however, are in general those whose energy levels are most nearly balanced.

We have compared the nucleus, now, to a crowded peapod, to a hole surrounded by a potential barrier, and to a set of ladders; but of course these are not accurate pictures of the true nucleus. We have used them only as convenient ways of trying to explain why the nucleus clings together at all, and why some nuclei stick together better than others. Even the ultimate particles of matter—electrons, protons, and neutrons—can no longer be thought of as little round balls; they are too ambiguous in their nature, behaving at one time like wave radiations, and again like actual particles. The thinking man, when once he is accustomed to the facts, discards all models and pictures as mental crutches, and accepts the atom and its nucleus as entities which he knows to exist, but which he cannot visualize as similar to anything he knows from everyday experience.

Nobel Prize Radioactivators



Irène Curie Joliot

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Prof. F. Joliot

JUST before last month's number of this magazine went to press, the Nobel Prizes for Physics and Chemistry were awarded to three scientists whose outstanding researches had already been described in it, and at that late date it proved possible only to insert in the proofs brief mentions of the awards. The article in question was entitled "Artificial 'Radium'" and was by Professor E. U. Condon of Princeton University. In it Professor Condon explained, almost prophetically of the prize awards as it later turned out, the remarkable recent work of Dr. James Chadwick of Cambridge University who has won the Physics Prize for discovering the neutron, and of the two Joliots of the Radium Institute of the University of Paris who won the Chemistry Prize. Photographs of the Joliots are reproduced above. The Joliots received the Prize jointly because they work as a team. Madame Joliot, however, signs her research papers Irène Curie. She is the daughter of the famous Marie Sklodowska Curie, a Pole who removed to Paris. The Prize was awarded to the Joliots for the discovery of induced or artificial radioactivity and the creation of new elements by atomic bombardment.

TODAY, as Professor Condon recently said, there is no depression in research in fundamental physics. Advances have come thick and fast and, at that, right on the heels of much shaking of the head by older men of science who had feared that the immense current of discovery which followed on the awakening of a stagnant science by the discovery of the X rays in 1895 was now drawing to a close. It has been young men, mainly in their thirties, who have made many of the recent advances.

It is becoming increasingly difficult, though most fascinating, to keep up with the world's current advances in physics. A year or two ago the Bishop of Ripon, in England, told a scientific gathering that science ought to take a vacation for a while. This remark soon became famous. Many commentators interpreted it to mean that the bishop felt we had already learned enough for our own good. What the bishop meant was probably half whimsical: the feeling, which many of us doubtless share, that the physicists have been making major hits faster than the average mere mortal could keep up with them, and that a breathing spell would permit those of us who were not geniuses to catch up with the trailers in the race and perhaps to keep the leaders at least within sight. But it is not merely laymen who have experienced this difficulty. Scientists themselves also feel it. Thus we find, for example, a biologist here and a chemist there, stating perhaps a bit sheepishly that they have had all they could do to keep abreast of developments in their own field of science and so, like non-professional persons, attending popular lectures on other branches of science in order to get some idea of what is going on in them.

We may go still further: Even among the physicists themselves the research has become so specialized that those who are working in different branches often cannot wholly understand what physicists working in other fields mean.

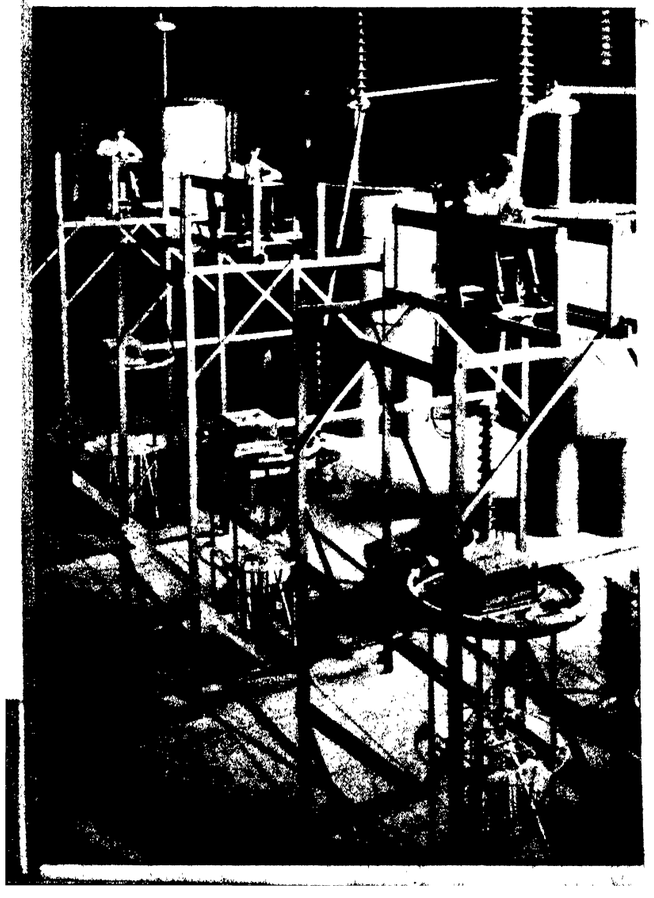
WHAT practical good are all these discoveries? Perhaps none—who knows? Yet few of those thus far made have failed before long to present big business with big bonuses. The physicist himself is interested solely in finding what this world is and just how it works—pure curiosity. But far-seeing business men are turning back to the physicists some of the millions realized. Seed.—*A. G. I.*

High Voltage Research for Commercial Use

By ANDREW R. BOONE

attery of huge transformers which are capable of producing a voltage 2,400,000. Note the comparative size of the men shown at the lower right

The wattmeter set-up, showing three engineers and the equipment with which they measure the power of strokes of man-made lightning



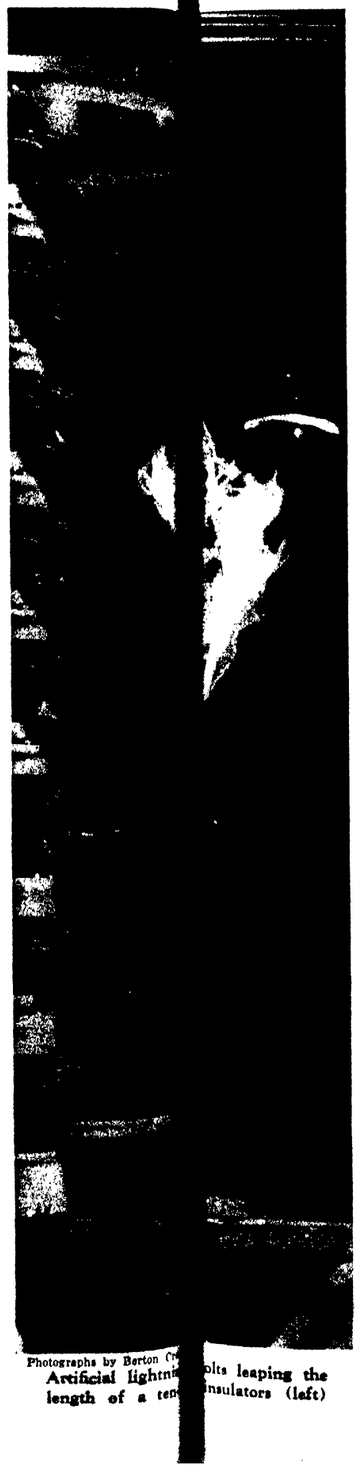
WITHIN the black walls of the Harris J. Ryan High-Voltage Laboratory, standing alone in an open field at Leland Stanford Jr. University, California, a crackling, blinding flash of lightning 10 feet long burst around the insulators supporting an automatic disconnect switch. Again and again chain lightning was poured into the circuit until, by delicate measurements, the engineers learned the insulators would withstand a lightning bolt carrying 830,000 volts under normal operating conditions.

Three decades ago, when the late Dr. Harris J. Ryan started his experiments with man-made lightning at Stanford, commercial voltages higher than 15,000 were not known. Within the next few months, conductors strung across a 275-mile expanse of desert from Boulder Dam to Los Angeles will carry the then undreamed-of power of 287,000 volts. It was to meet this and other like demands for long-distance transmission of power in the West that experiments by electrical engineers at Stanford have worked toward the safe handling of higher and higher voltages.

Here electrical engineers are playing with man-made lightning, erratic and destructive when untamed, but a valuable servant to humanity when controlled. How much voltage the lightning of nature carries is only guesswork, although engineers' estimates of that voltage range from 20,000,000 to 1,000,000,000. In the black room of the Ryan Laboratory, 30-foot bolts of man-made lightning, with 2,400,000 volts behind them, whip between gaps at the turn of a switch. While this does not compare with the fury of natural lightning, tests with this great power have resulted in development, for example, of circuit breakers which switch power off in 1/1000 of a second when lightning strikes.

A visit to the black high-voltage room carries you behind the scenes of many high-voltage projects, for there Dr. Joseph S. Carroll, the director, and his associates, have whipped baffling problems of power transmission. Inside the door of the lofty laboratory you find yourself facing a table covered with sections of cable cut to cord-wood lengths. Some are aluminum, others copper; some are bundles of wire, others are pipes almost 1½ inches in diameter. Nearby is more cable, wound on reels high as a man.

Since high voltage is like high water pressure, it pours electrical energy over a cable at such pressure that there is little loss in transit provided the cable is large enough to carry the load. Low voltage may be likened to low pressure. The volume may be started through one end of the cable but without pressure it peters out toward the end of the line into a mere trickle. Recently, in the Ryan Laboratory, Dr. Carroll has conducted experiments looking not only to protection of high voltage lines against lightning, but also to determine what size conductors are necessary to carry as much as 287,000 volts over a distance of 275 miles. How large in diameter the cables should be, how much copper or aluminum they should contain, whether they should be hollow or solid, what kind of surface they should have, were questions unanswered by precedent.



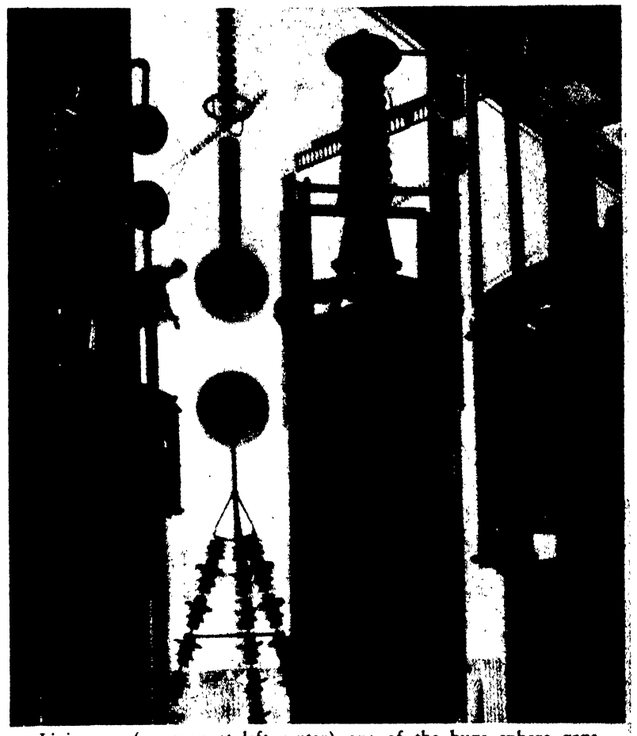
Photographs by Berton Cr

Artificial lightni olts leaping the length of a ten nsulators (left)

IN seeking answers, the laboratory staff strung up ¼-mile lengths of different diameters of cables, suspending them from towers extending across the fields nearby. Motor-dynamos in the power room and transformers in the laboratory shot into the cables a voltage of 600,000—twice that demanded for practical service. Losses were measured by carefully adjusted wattmeters. From these data the world's largest conductors were designed.

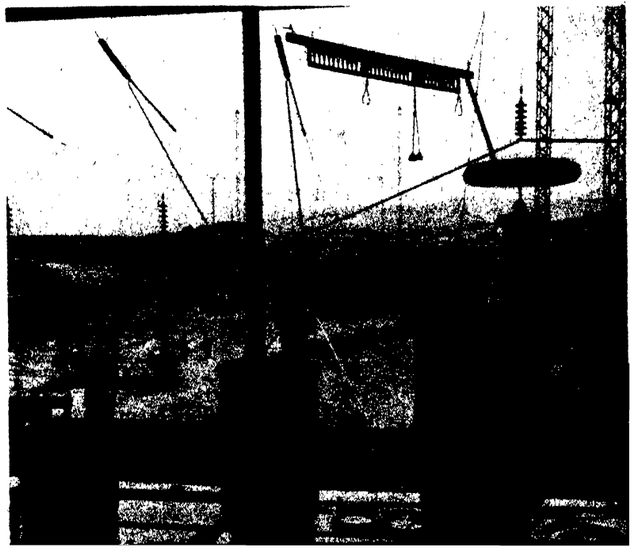
For certain phases of the work in the laboratory Dr. Carroll brought the mountains and deserts into the laboratory by constructing an ingenious "weather tube," a steel tank 30 feet high and five feet in diameter. Within this cylinder he produces climates at will, making them dry and hot for the desert, damp and cold for the mountains, and lowering the pressure for high altitudes. Thus, within a small space, "cord-wood cables" were tested under weather conditions approximating those on a line running through mountains and desert. These tests revealed that hollow conductors give the least loss on the world's highest power line.

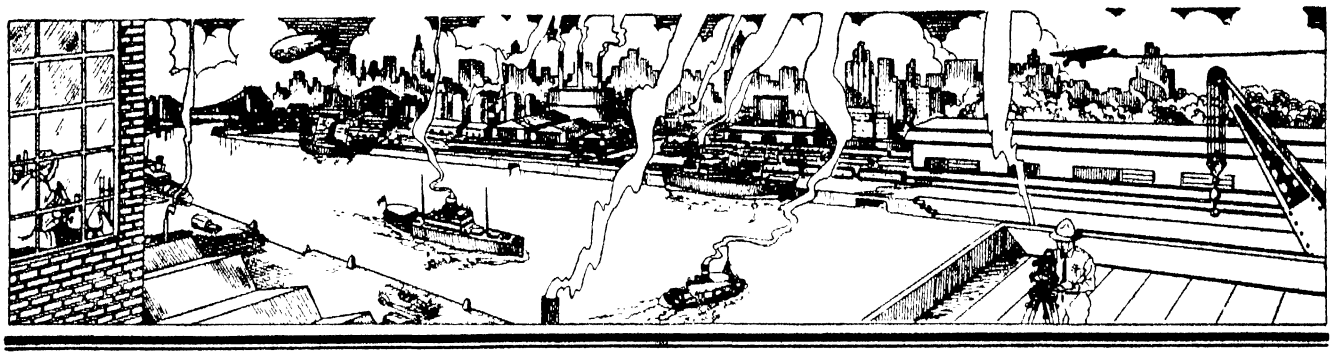
While he toys with artificial lightning, one bolt of which if misdirected could snuff out the lives of all nearby, Dr. Carroll hopes some day to catch a bolt of real lightning and direct the bolt into a photographic recording device to measure its strength. Somewhat more practically, he already is anticipating the day when engineers will demand means for handling a half-million volts over transmission lines. Since power is transmitted most economically at 1000 volts for every mile of line, he foresees the time when wired lightning will flash across the countryside in 500-mile steps, kicked along by 500,000 volts.



Lining up (see man at left center) one of the huge sphere gaps used as part of the wattmeter equipment for measuring high powers

A view from the Ryan Laboratory over the experimental transmissio towers and lines used in high voltage tests aimed at commercial us





THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.

Lehigh University

Bug Eat Bug

SAVING of thousands of tons of America's cane sugar supply from Hawaii, which has been destroyed in past years by an insect pest, is expected through the activity of another insect which has just been found to be established in the fields where

Pan-Pacific Press Bureau

How bugs battle bugs

the pest has been most destructive. *Elis pulchrina*, a small wasp from Guatemala, is the latest immigrant brought to this part of the United States to attack the worst surviving enemy of sugar cane in the territory. The Guatemala wasp is one of many parasites which have been introduced by the entomologists of the Hawaiian Sugar Planters' Association Experiment Station to bring various pests under control, and the latest of three to attack the anomala beetle.

The anomala does its harm while in the grub stage. The grub lives in the ground around the cane and eats the roots and the part of the stalk below the surface of the earth, depriving the cane of nourishment and weakening it severely. It has been considered a serious menace to America's sugar industry.

The adult wasp lays a tiny egg on a certain segment of the grub when the grub is in the ground around the roots of the cane. The egg hatches and a larva appears—what the layman would call, in common parlance, a "worm." The wasp larva gnaws into the grub, which is helpless to defend itself, and in about eight days there is very little of the grub left.

By that time the larva is ready to go into its next stage. It spins a cocoon—a shell of silky fiber shaped like a short, fat dirigible balloon—and remains in it while developing to adult form. In about three weeks a mature wasp gnaws its way out of the cocoon, finds a mate and carries on the breeding cycle.

The anomala beetle stowed away somewhere in the Orient—probably in Japan—and entered Hawaii by accident about 1908. Entomologists went to the Orient to seek its natural enemies. The parasites found in Japan did not become established in Hawaii, but two species from the Philippines did.

WIRE MILEAGE

TELEPHONE wire in use in the United States totals 87,000,000 miles. This is 56.92 percent of the world's total, Germany being second with 10.14 percent.

Moving A Highway With Hose

A USE for hose believed to be without precedent has just been made by the New Jersey State Highway Department. Along New Jersey Route No. 26, between New Brunswick and Trenton, the first eight miles of a 40-mile stretch of concrete roadway has been moved 12 feet to one side to provide a safety island in the center of the present four-lane highway. This island was constructed in an effort to reduce the number of accidents; during 1934 there were nearly 90 motor car deaths on this highway. New Jersey highway officials are hoping that the addition of the safety island will eliminate many of these accidents.

Ready to insert the three-inch hose in the unusual highway-moving system described in these columns

The present highway is made up of three concrete slabs, the center and west ones being 14½ feet wide and the east slab 10 feet wide. The 14½-foot slab on the west edge of the highway was the one moved. A new slab 10 feet wide will be built outside of the one moved, so that when finished the completed project will present a highway 25 feet wide on each side of a center 12-foot safety isle.

The highway strips are moved three inches at a time. Blocks are then inserted for the next sidewise "push"

Since it was decided to move the road rather than build over or break it up, it became a problem of moving the slabs without damage. Mr. Sigvald Johannesson, New Jersey State Highway Engineer, conceived the idea of accomplishing this with hose. The road was moved in approximately 500-foot lengths, which consist of fourteen slabs, each slab being 35 feet long. After

the road shoulder had been graded down to the proper level, the asphaltic joint filler in the longitudinal joint running lengthwise of the section was removed by means of a steel blade drawn by a steam roller.

The removal of this joint filler left a crack about half an inch wide. Into this crack was inserted a flattened length of three-inch United States Worthy Linen Hose, previously soaked in water and treated with graphite. Five 100-foot sections of this hose were coupled together and air under pressure was forced into the hose. As the hose expanded, it forced the entire 500-foot length of roadway to move approximately two inches.

The separation between the slabs was then wide enough to accommodate an especially constructed, double jacket cotton rubber-lined six-inch hose. The process of expanding the hose with compressed air was then repeated, the slabs moving three inches with each inflation. After each inflation and deflation, proper blocking was placed behind the hose and the process repeated. Each cycle consumed somewhat less than five minutes. The moving proceeded at a rate of approximately 800 feet of slabbing per day. Mud jack crews followed the moving gang and formed a new permanent base for the transplanted highway by pumping a fluid mixture of top soil and cement through small holes previously drilled through the concrete.

When one realizes that every cycle of this operation consumed somewhat less than five minutes and that in that time a strip of concrete 14½ feet wide, 500 feet long and weighing approximately 840,000 pounds was moved three inches, the ingeniousness of this engineering feat is truly amazing.

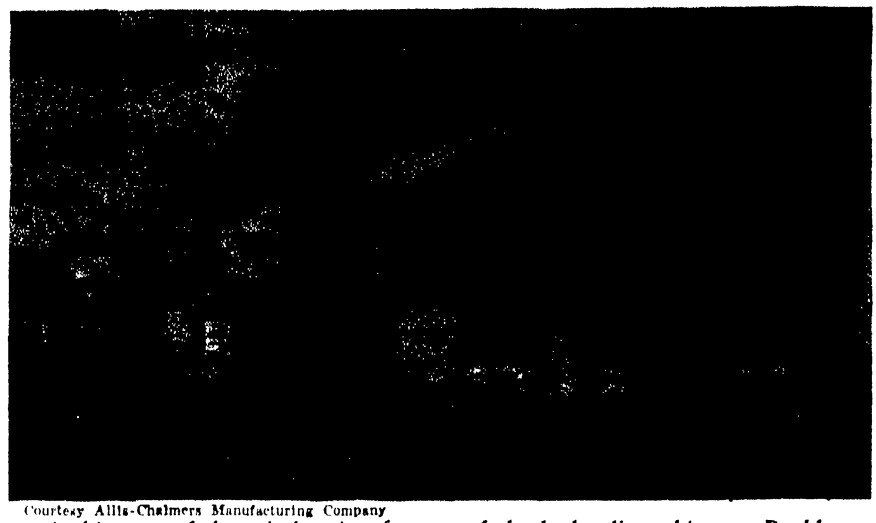
Home Gas Generator

A NEW gas generator, which will produce gas on farms or for rural homes, and will burn almost any kind of fuel that may be available, has just been placed on the market. The gases it produces include carbon monoxide, methane, and hydrogen in a mixture which is satisfactory for cooking, lighting, refrigeration, or other domestic uses. The fuel used may be any combustible vegetable or fatty matter such as wood, sawdust, leaves, corncobs, cornstalks, straw, and even old shoes, rags and other waste material. The makers, the Economy Gas Generator Company, say that after they are installed these generators are operated practically without further cost and will last a lifetime.

Gas generator for the home

A "run" is said to take about 3½ hours, no skill being required for the operation, for the process is one of controlled, high-pressure destructive distillation. In this process the gases are distilled from the material used and, as far as possible, all crackable products distilled from the material are also cracked into gas. The manufacturer claims that the gas produced by the generator has a heating value of approximately 500 British thermal units.

Besides the combustible gases it produces, there is also a quantity of creosote and creosote water produced in the run. Needless to say, these products are also useful on the farm.



Courtesy Allis-Chalmers Manufacturing Company

A shipment of the spiral casing for one of the hydraulic turbines at Boulder Dam. Six cars were necessary to carry the complete casing; 26 cars were required to transport the entire 115,000 horsepower, 1,250,000-pound turbine

Non-Skid Tire

FOR years various kinds of tires have been advertised as non-skid, yet we have known that most of these were far from perfection in non-skid qualities. Now, however, there is one which seems to approach very much closer to that long desired point. This is the new General Dual-10.

Narrow fins reduce skidding

This new tire departs rather radically from the old practice of building complex patterns on the tread. Its virtue lies in the thin peripheral fins which are but ⅛ of an inch wide and stand ¼ of an inch high on the tire, with less than $\frac{1}{16}$ of an inch space between. On first examination one would say that these fins are too soft and flexible, but that appears to give them their non-skid characteristic. As shown in tests, these fins, under the weight of a car, bend into a snaky pattern with the applied torque of the engine or in braking, so that they give a squeegee effect. With this snaky twisting of a number of the fins, there will always be many edges which are opposed to the line of motion of the car, thus squeegeeing the roadway and giving better traction for driving or braking.

Moving pictures of cars using these tires under test show that they will stop a car dead-straight on a wet pavement at speeds at which cars with ordinary tires will skid badly. The manufacturer claims that they will stop a car quicker and more safely on a wet pavement than will ordinary tires on a dry pavement.

MAN'S COSMETICS

OF all things: Men with eyes darkened to make them large and interesting and hair curled with curlers, and with perfumes and powders commonly used, as mere man says, for women's vanity! Egyptian "he-men" of 1500 B.C. wore such make up—and probably their wives called them vain. These facts were learned from examination of the family tomb of the private secretary to Queen Hatshepsut.

New Synthetic Rubber Shows 500 Percent Elongation

AN oil-proof synthetic rubber with a tensile strength up to 1700 pounds per square inch, has been put on the market by the Thiokol Corporation. While it will stand even lower temperatures, it is claimed to be very flexible at –45 degrees, Fahrenheit. Among the many features claimed for it are: Elongation around 500 percent; abrasion resistance of the order of rubber; tear-resistance equal to or better than rubber; mild, not objectionable, odor; and, in addition to being oil-proof, good resistance

to Duco thinners, lacquers, printing inks, benzo-gasoline blends, and most ordinary solvents. It is sold in crude sheet form corresponding to natural crude rubber.—*A. E. B.*

TEMPERATURES

WHILE the outside surface of the sun is only 6000 degrees, Centigrade, Dr. T. E. Sterne, astrophysicist of Harvard College Observatory, recently guessed that the internal temperatures of some stars must be as much as 1,000,000,000 degrees, Centigrade. We say "guessed" because there is no known way of making an actual determination.

A New Armor Piercing Shell

DURING the past 30 years, the development of long range naval gunnery has been a never-ending problem to the gun-mounting manufacturer, the ship constructor, the maker of optical instruments, and the steel master. When the armament manufacturer has designed a high-elevation mounting capable of standing up to the enormous recoil stress of a big gun firing at, say, 30 degrees, the naval constructor has to allow for the increased strain and must strengthen his hull to stand the shock. Then the makers of gunnery control devices—the range-finders, director gear, and the dozen and one complex pieces of equipment which go to make up mechanized gunnery—provide of their best to insure hitting at maximum range, leaving it to the steel master to furnish the armor-piercing shell. The ability of the shell to pierce the target and burst would seem to be something we should take for granted as the final factor in the delivery of a crippling salvo.

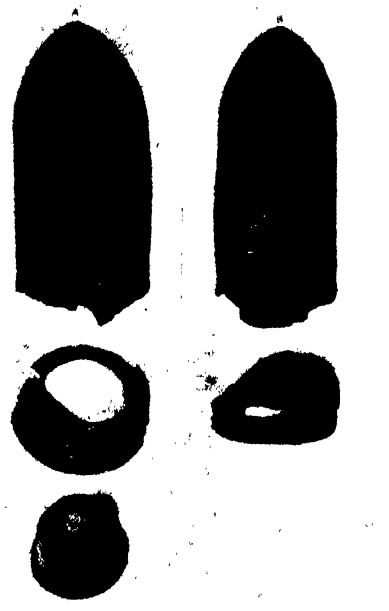
It so happens, however, that the projectile provides a difficult problem. Time and time again, when perfect co-ordination has resulted in high percentage hitting at long ranges, it has been found that shells fail to burst when they have pierced thick armor. Examination of them has shown that not only has the fuse been rendered unable to perform its function by becoming mutilated and detached from the body of the shell with the breaking away of the base of the shell, but the explosive charge itself is made practically harmless by being provided with a large vent.

It is not a question of shells being badly made; the most stringent system of selection would seem to be no safeguard against this happening, as it is simply a matter of the luck of the hit! With shells of ordinary construction, fracture of the base-end may occur at any velocity and does so in a percentage of rounds when striking the armor at high angles of incidence. With increasing range and diminished striking velocity this percentage becomes greater until a point is reached when such failures become inevitable.

Formerly, the manufacturer was concerned in producing a cap which would enable the projectile to pierce the armor; now that the cap difficulty has been greatly reduced, it is frequently the base which fails to protect the fuse. The reason for the fracture is that when a shell hits obliquely it tends to turn to the normal in its passage through the plate owing to the inequality of resistance offered to the two sides of the ogival head. This turn to the normal in so short a space of time causes a rapid and violent swing of the shell so that under certain conditions of velocity and thickness of plate its base-end will strike the edge of the hole with such force as to tear the base off—or at least distort it to such an extent as to damage and prevent the action of the fuse.

These unfavorable conditions are most likely to occur when the projectile strikes thick hard-faced armor at long ranges with an increased obliquity of impact due to the greater angle of descent. Although the ordinary type of projectile may perforate under these conditions, the shell will too often be blind for the reasons already mentioned.

It was to overcome this difficulty that the British firm of Messrs. Hadfields, Sheffield, turned their attention to, and succeeded in producing, a shell which would be proof against this type of failure and would isolate the vital functions of the shell and fuse from the effects of the base-end blow.



Courtesy Hadfields Ltd

The effect of perforating an armor plate, at high angle of impact, with (left) an ordinary shell, and (right) with the relief base type

In these new and patented shells, the result of the violent swing to which they are subjected during perforation of the armor is merely to remove the non-essential portion of the base and leave a fully effective projectile; that is, one in which the bursting charge remains completely enclosed and in contact with the fuse which is retained intact as shown in the accompanying illustrations. These are reproduced by permission of Messrs. Hadfields who hold world patents (including those for the U.S.A.) for this and several other important improvements also patented, so necessary for the manufacture of a successful armor-piercing projectile.

It may also be added that from a tactical point of view the benefit in question is of far-reaching importance because any attempt to increase the effective fighting range of an existing shell means an increase in the angle of impact; or, if to avoid this, its ballistic flight is improved by increasing its sectional density, an increase in its length is necessitated. Unfortunately, an increase in either the angle of descent or the length of the shell raises immediately the risk of base-end failure which has thus become the limiting factor against an increase in effective fighting range. The removal of this limiting factor and of the risk of failures from other causes, by means of the shell manufactured under the Hadfields' patents, would seem to open up new tactical possibilities in which a fleet so equipped can choose its fighting range where it can inflict heavy damage on its opponent while remaining beyond the reach of any effective reply.

At this time when a revival of naval activity is imminent it is a matter which calls for serious consideration.—*Dr. Oscar Parkes.*

TRANSPLANTED HEADS

IN Vienna, "nymphs" of grasshoppers fed and shed their skins in regular fashion after exchanging heads with other "nymphs." Dr. Atma Malabotti, who performed the transplanting operations, says that the female grasshoppers grew up, eventually laid eggs, and hatched quite normal little grasshoppers.

Skin Graft Triumph

A NOTABLE triumph in skin grafting has been scored by an Australian surgeon. New eyebrows and lids have been grafted over the staring, though still functioning, eyes of a youth who was badly burned by acid. Piece by piece, skin from other parts of the body is being grafted to the face and other damaged parts.

Eight operations have been performed at Sydney and there are still three more to be done. Medical men from all over Australia have been watching the progress of the case and photographs of the successive stages have been forwarded to the British Medical Association.—*Australian Press Bureau.*

A Lost Gold Art Revived

GOLD beads so tiny that a row an inch long would contain a hundred of them figure prominently in the intricate jewelry art of the ancient Etruscans, who throve in Italy before the rise of Rome. But the making of them became a lost art.

Now an English goldsmith named Blackband is able to make them again, by a process which he believes is identical with that used by the long-dead early masters.

Mr. Blackband's rediscovery was more or less accidental. He spilled a small quantity of molten gold, which splashed as it fell. When he gathered up the scattered precious metal, he found that the smallest drops had hardened into perfect little spheres. Now he purposely splashes molten gold-copper alloy onto a sloping shelf in a little box, and turns out "Etruscan" beadlets in quantity.

The next problem was to find out how to form them into the complicated patterns of double lines, hexagons, and triangles such

as figure on Etruscan jewelry. This proved to be not particularly difficult. Drawing a wet line with a finely pointed camel's-hair pencil, Mr. Blackband saw his beads range themselves in rows along it, held by the surface tension of the water.

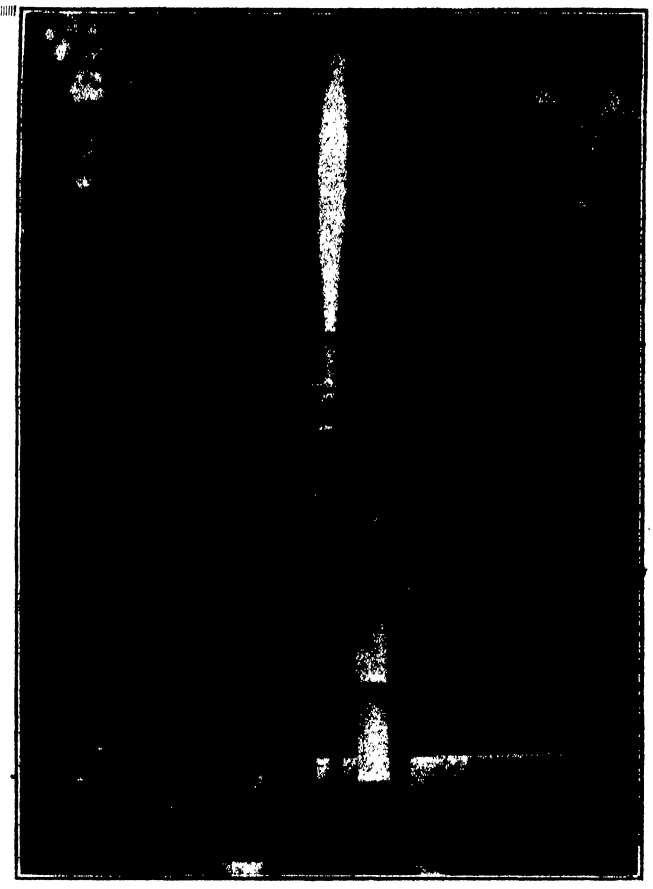
Then he used a wet, hair-fine wire. The beads adhered to the wire. He bent it into the desired pattern, the beads still sticking in place, and then heated it until the wire and beads fused together. Now he can duplicate any pattern the Etruscans had.—*Science Service.*

DAYLIGHT

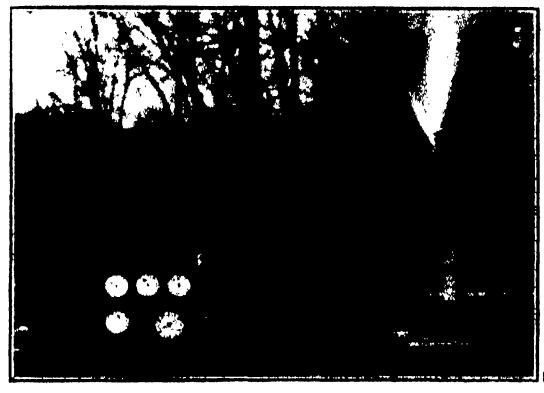
TED LARSEN, United Air Lines meteorologist, points out that during early morning and late afternoon hours the sun is visible from planes in flight while the earth below is in darkness. From an altitude of 10,000 feet, the sunrise may be seen ten minutes earlier than from the ground.

Home Airplane Design

WALTER H. KORFF'S "Lightplane Design" is a workmanlike book with some 110 illustrations which, without any difficult mathematics, takes up the aerodynamics, balance, and general design of a small airplane. The construction drawings are good though not highly detailed. For an amateur airplane constructor no better introduction has been published or given anywhere. Also, we know quite definitely that a number of amateur constructors have produced satisfactory small airplanes in various parts of the country. Whether such home-made aircraft are to be encouraged or not is another question. Even with the machines produced by the best manufacturers in the country, with fine engineering staffs, equipment is still a cause for accident. Homemade machines will provide an intensely interesting hobby, but they certainly will not increase safety. *A. K.*



A close-up of the experimental rocket nozzle in operation, showing how reaction readings are obtained. The containers for alcohol and liquid oxygen are held in the framework. Fuel lines connect them to the combustion chamber and the nozzle at the top



The test stand and the instrument board, where the pressures in the alcohol and oxygen cylinders are recorded during rocket experiments

Pioneer Work with Rockets

THE American Rocket Society is composed of well informed men, many of them engineers and chemists, who, after an initial burst of uncontrolled enthusiasm, have settled down to a thoroughly practical yet scientific series of tests. The Society is still too young to employ whole time professional investigators, but the members devote all their spare time, Saturday afternoons, and Sundays, and steadily increase their knowledge and mastery of the problems involved.

We were privileged visitors on a recent Sunday to watch the Society's new proving stand in operation. It is obviously both expensive and unsatisfactory to build a rocket, fire it, and perhaps lose it forever. At this stage of the game it is better to learn on a proving stand exactly what may be expected of a rocket motor under varying conditions.

Briefly described, the proving stand comprises an alcohol container, a container for liquid oxygen, piping and valves for bringing the two fuels together into a combustion chamber, and at the top of the combustion chamber a variety of nozzles which can be screwed in. The fuel inlets are two pairs of opposing orifices in the combustion chamber; the small pair for fuel, the larger for oxygen. The liquid oxygen, of course, is under pressure already. The alcohol is brought up to pressure by compressed nitrogen. A series of pressure indicators are mounted on a board and show the pressure in the explosion chamber, in the alcohol cylinder, the oxygen cylinder, and so on. A powder fuse is used to ignite the mixture. The charge consists, as a rule, of one pint of alcohol and two pints of oxygen. A careful technique in loading, mixing, and firing has been developed. The reaction of the upgoing nozzle is measured on a hydraulic pressure gage mounted at the bottom of the firing stand. The intrepid scientists get rid of the crowd of observers by blowing a whistle and seek shelter at a distance behind a strong wooden partition and via steel helmets.

Once or twice the combustion chamber itself has burst. At other times the firing is incomplete. Still more frequent is the burning out of the nozzle. The nozzle material has to withstand temperatures of 3000 degress, Fahrenheit or more, and the erosive properties of gas shooting out at several thousand feet per second. Nozzle after nozzle has been tried and the material which will be entirely satisfactory is still to be found. Tungsten carbide has been suggested and other materials are also under consideration.

A typical short run with a pressure of 300 pounds in the firing chamber lasting nine seconds developed a maximum thrust of 59 pounds and an impulse of 430 pounds a second.

The most difficult problem remains in the development of a strong combustion chamber, adequately cooled, with a nozzle which can stand up indefinitely. We hope to make further visits to the scene of these attempts and to report more fully on progress achieved.—*A. K.*

Cold Weather Air Operation

JUST about the time of writing this note, the difficulties of cold weather operation force themselves on the attention of both the automobile and the airplane oper-

ator. The specialized experience of Canadian aviation, with its immense wild areas and intense cold, is of considerable interest to such operators and they would do well to study a paper read by Alan Ferrier (of the Royal Canadian Air Force) before the Society of Automotive Engineers.

When winter flying operations started seriously in Canada shortly after the World War, the technique at the beginning and termination of a flight was terribly laborious. Describing the starting of a four-engined, water cooled, Handley Page bomber the author writes ". . . Hordes of assistants 'chain-ganging' buckets of boiling water into the radiators until the outlets on the far end of the water manifolds ran hot; of pouring hot oil into the tanks; of warming at least 48 spark-plugs on a shovel over the fire and then putting them in; and of the fourth engine sulking and the other three having to be shut down for fear of overheating on the ground; and then of starting the whole process over again."

Of course the introduction of the air-cooled engine reduced these difficulties appreciably. But many difficulties still remain, as borne out by the following remarks: "To ensure a start it has been and still is the practice to warm the motor by encasing it in a heavy canvas cover or a nose tent supported on the vertical propeller and applying heat under the cover by means of a blow lamp, gasoline stove, or even a wood-burning stove. This process takes from half an hour to an hour and the cover has to be removed before an attempt is made to start. The oil was poured in at the last possible moment. If for any reason the engine refused to start, the whole process of draining and re-heating the oil, replacing the engine cover and warming the cylinders had to be repeated."

For several years these arduous conditions were accepted as the inevitable accompaniment of winter. They were not only arduous but dangerous, with an obvious fire hazard. Now an attack has been made from a new angle: the modification of lubrication so that a "cold" start is possible.

Correct lubrication depends upon the "viscosity" of the oil. If the viscosity is too high the flow under the pump pressure will be too small, and though the oil film in the bearings may be strong enough to take bearing pressures there will not be enough oil spilled to lubricate the cylinders and pistons. Cold increases viscosity, and hence cold means difficulties in lubrication.

These difficulties have been met by the following simple measures: The technologists were asked to produce an oil which would pour easily and have little viscosity in the coldest weather. They responded by producing an "arctic" type oil which flows readily at −20 degrees, Fahrenheit. Oil tanks and feeder lines were protected as much as possible from the cold atmosphere. To insure starting, some highly volatile ether was injected at the start of a run into the engine manifolds.

Without any of the laborious technique described previously, cold starts are now easily achieved. With further progress in arctic oils, Mr. Ferrier thinks that a cold start will finally be possible just above the freezing point of gasoline; namely, −70 degrees, Fahrenheit. There is no object in going below this point, since it probably is the limit of human endurance.—*A. K.*

The composite map of Connecticut made from aerial photographs

GLASS RAZOR BLADES

AFTER long experiment, Czechoslovakia is reported to be turning out razor blades made of glass. The importance of this development lies in the low cost of the blades, mainly, although the fact that they cannot be resharpened will mean more sales for the manufacturer.

Aerial Photograph of a Whole State

THE entire state of Connecticut can be seen in a single aerial map which was exhibited at the Tercentenary Industrial Exposition held in Hartford. This map has dimensions of 18 feet by 13 feet and an area of 234 square feet. The map was made by flying at an altitude of 11,400 feet by Fairchild Aerial Surveys, and includes 34 composites which were derived from 10,479 exposures. When the huge picture was hung on the wall of the State Armory at Hartford, spectators using field glasses to magnify detail were able to pick out small landmarks such as hedges, chicken houses, trails, or small streams. *A. K.*

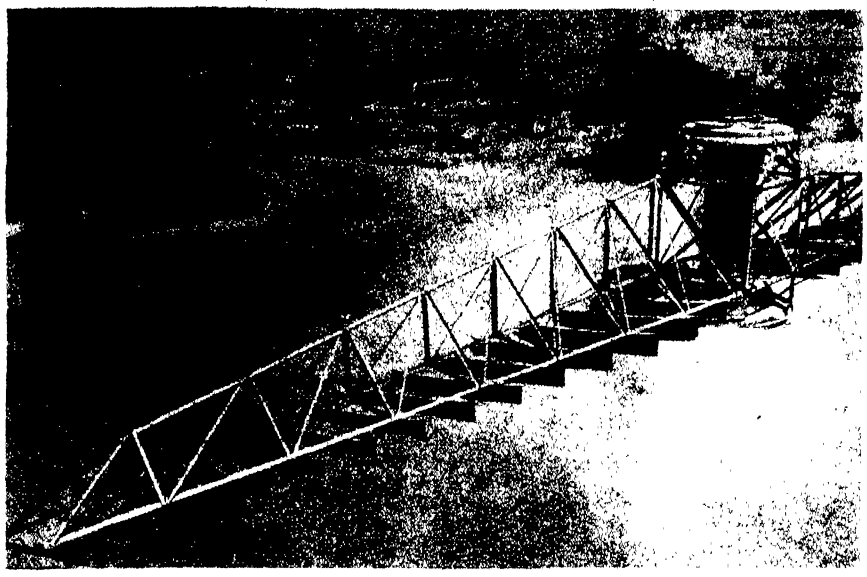
Machining Propeller Blades

THE metal airplane propeller is better in almost every way than the wooden propeller, and is rapidly displacing the latter on airplanes of every type. Its one disadvantage is in higher cost. Therefore, it is highly desirable to have "profiling" machines for low-cost production of metal blades, such as the one developed by the Engineering and Research Corporation. The development work extended over four or five years, and the machine includes a variety of mechanical devices, a complete description of which would involve many drawings and a lengthy pamphlet. But if our readers study the two photographs carefully, they will have a very fair general idea of the functioning of this device, which has proved highly successful and is being widely accepted by the aircraft industry.

A single master cam or form of solid cast iron is employed. This master cam, with a peculiar form, has a length of two inches more than the maximum width of the blade being produced. The cam rotates and is directly geared and synchronized with the table holding the blade forging which is fed horizontally past the cutter. Owing to this synchronization, each line radially on

The roller is guided by the master cam and, in turn, guides the cutter that does the work on the propeller blade

The propeller forging, with its bed, travels horizontally, while the cam-guided cutter gradually shapes the blades



One of the Dorr Clarifiers for the All-American Canal desilting plant

the master cam or form represents a corresponding element of the propeller blade. Of course, a separate master cam is needed for each side of the blade.

With the aid of a roller, traveling on the cam, and an appropriate linkage, the cutter travels back and forth with simple harmonic motion, and oscillates freely about a trunnion which permits the necessary vertical travel.

The blade is fed horizontally past the cutter from tip to hub. At about 18 inches from the hub, the cutter lifts off the forging and the machine is automatically shut off. The table is then cranked back to the starting position by means of a hand wheel, a new forging is inserted, and the machine is restarted by means of a conveniently located push button switch. The propeller is supported on the table by a hand and tail stock. The cutter is of special design and has a peripheral speed of approximately five thousand feet a minute. Lengths of strokes, position relative to the center line of the table, and number of strokes per minute can all be varied. The cutter can remove three eighths of an inch of metal with one powerful cut.

To produce the master cam or form, the cutter and roller are reversed on the machine. A master blade is placed in position on the table, and guides the roller. The cutter (which is now located where the roller was previously) now fashions a wooden block which is on the master camshaft. The iron casting is fashioned from the carefully cut wooden pattern.

The blade of a ten-foot propeller can be machined in one hour, and generally but a single cut is necessary, though it takes one hundred and fifty hours to produce the master cam. We saw this machine in action, and were positively fascinated by its ingenuity and accuracy.—*A. K.*

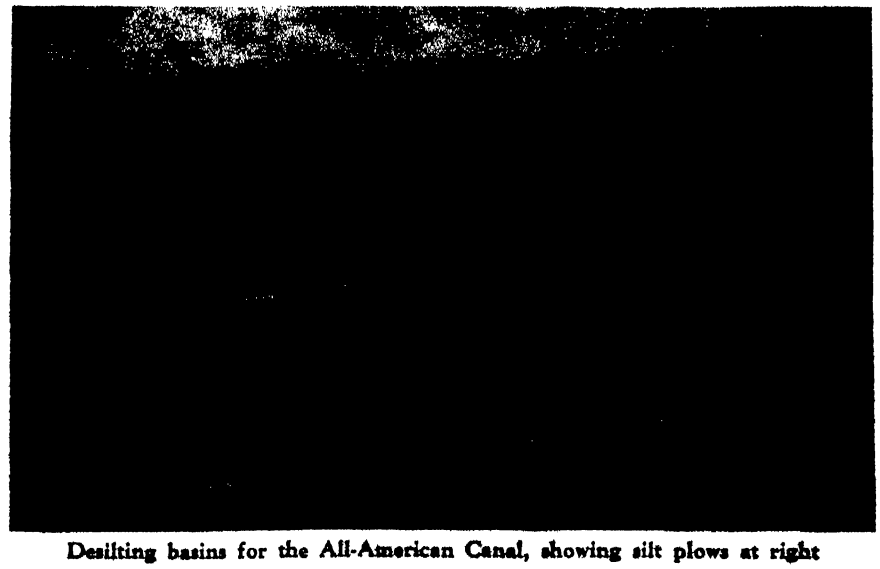
70,000 Tons of Silt Daily

As much as 70,000 tons of silt a day will be removed from something like eight billion gallons of Colorado River water pouring into the new All-American Canal from the Imperial Dam. This desilting process will be performed by what will be the world's largest water treatment plant, to be constructed 15 miles northeast of Yuma, Arizona, at the above-mentioned dam which is about 250 miles below Boulder Dam. The solid matter removed by this plant will at times amount to 70,000 tons daily while the average will be about 50,000 tons.

The desilting plant shown in the accompanying illustrations will have mechanically-operated Dorr Clarifiers which have been worked out by the Dorr Company, Inc., in collaboration with government engineers.

The desilting plant will consist of six huge settling basins, each approximately 769 feet long, 269 feet wide, with an average depth of 14 feet, arranged in pairs. Each pair of settling basins will be fed by an influent channel, located between adjacent basins, and these influent channels will, in turn, receive their water from the headworks at the west end of the Imperial Diversion Dam where the rate of flow is to be controlled by four roller gates, each 75 feet long and 23 feet high. The inflowing raw water will be uniformly distributed and will flow across the basins to the effluent side, depositing en route upon the bottoms of the basins the greater part of the suspended solids.

The removal of deposited silt is going to be accomplished by the largest battery of Dorr Clarifiers ever installed. Seventy-two of these mechanically-operated clarifiers —measuring 125 feet in diameter each— will continuously plow the accumulating solids to outlets in the bottoms of the basins whence they will be continuously discharged into sluicing channels and returned to the Colorado River below the diversion dam.



Desilting basins for the All-American Canal, showing silt plows at right

GASOLINE MOONSHINERS

Officers, finding and destroying a moonshine still in the hills of eastern Washington county, Ohio, were puzzled by the absence of mash barrels when they first sighted the still. Investigation showed that the plant was producing gasoline, thus evading the Federal tax of one cent per gallon on gasoline at the refinery.

Conquering Two Plagues

A major triumph in disease fighting in Sweden, reported at the meeting of the American Public Health Association, has fired the enthusiasm of American health officers engaged in what seems like a hopeless fight against the same diseases. The triumph, reported by Dr. Einar Rietz, health commissioner of Stockholm, is the practical eradication in Sweden of the two venereal diseases, syphilis and gonorrhea.

American health officers trying to accomplish the same results here must fight not only the disease but *an antagonistic public opinion which largely forbids even the mention of the diseases by name.* Yet these unmentionable plagues are the cause of more suffering and disability than any other communicable disease. The point is that syphilis and gonorrhea are diseases as are typhoid fever, tuberculosis, and yellow fever. They may be brought under control and practically wiped out by much the same methods that have eradicated yellow fever from this country and have brought so many other former plagues under control.

Using the familiar and trusty weapons of all disease fighting, the number of new cases of syphilis in Sweden has been reduced from 6000 a year to 431, Dr. Rietz reported. The population of Sweden is about the same as that of the state of New York, outside of New York City. Best estimates of the number of new cases in

New York state every year reach 11,000.

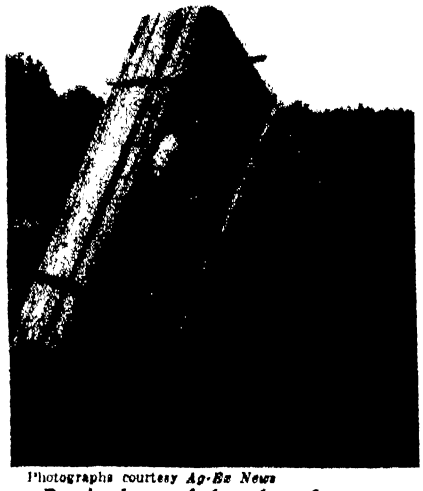
One feature of the Swedish method of handling the disease is provision of free medical and hospital care and medicine to any patient who has syphilis in the infectious stage. All patients must take treatment. Those who do not are subject to various penalties. Yet Dr. Rietz assured his American colleagues that personal liberty is safeguarded as carefully in Sweden as in the United States. Cases are reported to the health department without the patient's name. Sources of infection must be reported just as in the case of typhoid fever or any other communicable disease. Cases of syphilis are now so rare in Sweden that professors have difficulty in finding material to use in teaching medical students.

Encouraged by the Swedish experience, American health workers are hoping they will be given the opportunity to repeat the triumph over these two plagues in this country. *—Science Service.*

Reclaiming "Deadheads" with Dynamite

LEGION are the tales of the mighty log drives down the Menominee River, which takes its source in the upper peninsula of Michigan, where the Brule and Michigan Rivers meet. Millions of the great white pine trees, once standing in grand forests away in the sands of Michigan and Wisconsin, were fed into the maw of this scenic river, and floated to the one-time flourishing sawmill towns that are now the prosperous cities of Menominee, Michigan, and Marinette, Wisconsin, located where the river empties its cold spring water into Green Bay.

Paul Bunyan, the mightiest of all loggers, a legend tells, was always the first to deliver his drive to the Menominee and Marinette sawmills. When his season's sawing, skidding and "decking" on the river's banks were done, he did not wait for the ice to thaw. He commanded his seven mighty ax-men to chop large blocks of ice forty rods long and of the river's width, in advance of his drive. With mighty tongs of his own design, harness made of 37-pronged deer hides and porcupine quills, and his great Blue Ox, he hauled the blocks of ice ashore, out and in again, as his logs floated down stream. Paul Bunyan never lost a log on any of his drives on the Menominee River. There is yet to be found a single white pine "deadhead" in the river bearing his brand mark. Paul Bunyan was circumspect; his sour dough cooks never fed a flapjack to a lumberjack who would not respect a white pine log from the moment his seven mighty ax-men felled the tree until the log was delivered to the mill.



Photographs courtesy *Ag-Ex News*

Barricade used by shot firer reclaiming "deadheads" by dynamite

In reclaiming logs embedded in the silt and gravel of a river bed, explosives were used to cut a new channel through the mass of silt, thus permitting the river water to flow through, scour the remaining silt, and uncover the "deadheads"

Less sagacious were those who followed Paul Bunyan, says Alfred Mathewson, writing in the *Ag-Ex News*. Their deficiency is evidenced by the presence of countless "deadheads" embedded in silt and gravel in the bottom of the Menominee River.

Recently the reclamation of these "deadheads" has been accompanied with the assistance of dynamite. To make the required channel, cartridges of Ditching Dynamite were placed at intervals of 18 inches and at a uniform depth of eight inches along the site of the new channel. The cartridge in the end hole contained an electric blasting cap. Leading wires were attached to the wires of an electric blasting cap, and the other ends of the leading wire fastened to the terminals upon the blasting machine placed at a safe distance from the dynamite location. The presence of sufficient moisture in the ground permits the "shock-wave" to propagate throughout the entire length of the required ditch.

The quantity of explosives was not large, nor was much time required to load the necessary charges, but the employment of explosives to expose a valuable "deposit" of timber is one more example of what can be done with dynamite when ingenious and intelligent methods are employed.

Chemistry in the Movies

HOLLYWOOD studio technicians have been trying to find some substance that will act and look like lava in the volcanic scenes of "The Last Days of Pompeii." They finally found that powdered aluminum mixed with water gives a perfect photographic effect. As it runs quite rapidly, however, the eruption scenes had to be filmed in slow motion.

The filming of "Dante's Inferno" called for some kind of fire that would allow actors to walk through flame, and not be burned, or even heated. The Arthur M. Maas Laboratories, of Los Angeles, finally perfected "cold fire" which could be delivered in cans, and is a nicely balanced compound of an inflammable solvent and one that is not inflammable. The burning ingredient furnishes the flames—and beautiful flames they are—while the non-inflammable ingredient actually cools the flames, and keeps the actors safe and comfortable. *—A. E. B.*

Wider Use for Sponge Rubber

WHILE many uses have been found for the well known sponge rubber, heretofore there has been no practical way to slice it into thin sheets. Manufacturers realized that many additional uses could be found for this resilient, cushion material if they could but cut it in thicknesses less than ¼ inch, which was formerly the lower limit of slicing operations. It has, of course, been manufactured as thin as ⅛ inch but when so made it must have a rubber skin on both sides which naturally detracts from its peculiar qualities.

Now, by a new process worked out by Minneapolis Linen Company, Inc., sponge rubber may be sliced to 1/32 of an inch, with a high degree of uniformity. If the porosity will allow, an even thinner sheet may be attained. In this process a solidifying agent is first introduced into the pores of the rubber by immersing it and squeezing it between rollers. These rollers expel the air and as the rubber again expands the solidifying agent is drawn into the pores. In a short time the piece becomes fairly hard so that the rubber is in the form of a solid block. From this point on it is a simple matter to run the block through a slicing machine which cuts with a sharp wheel such as those used by butchers. As with the butchers' machine, adjustment can easily be made to regulate thickness of slice.

One of the "deadhead" blasts

After slicing, the solidifying agent is removed from the slices by placing them in water for a few moments. When dried once

Fourth Edition. Revised Autumn, 1935

AMATEUR TELESCOPE MAKING

Foreword by Dr. Harlow Shapley, Director Harvard College Observatory

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" II. Making the Mounting
" III. 100 Ft Sun Telescope
" IV. Wrinkles
" V. Adjusting the Telescope
" VI. How to Find Celestial Objects
Chapter VII. Telescope Housings
" VIII. The Prism or Diagonal
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" X. The Cassegrainian
" XI. Making Eyepieces

PART II. Rev. William F. A. Ellison, Director, Armagh Observatory

Chapter I. The Reflecting Telescope
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PART III. Design Principles of Mountings, by Russell W. Porter (New matter—19 pages)

PART IV. The HCF Polishing Lap for Telescope Mirrors, by A. W. Everest (New)

PART V. Motor Drives for Telescopes, by John M. Pierce of the Telescope Makers of Springfield (New)

PART VI. Instructions for Silvering Telescope Mirrors, by U. S. Bureau of Standards

PART VII. Grinding and Polishing Machines (used by a few who enjoy making them, though most mirrors and lenses are made equally well by hand, and 95 out of 100 are hand made)

PART VIII. Dr. Charles S. Hastings, Prof. Physics, Yale

Chapter I. Theory of Eyepieces
Chapter II. Types of Eyepieces

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Chapter I Solar Research for Amateurs
" II. Making the Spectrohelioscope
Chapter III Making a Spectroscope and Spectroheliograph

PART X. Contributions by Advanced Amateurs

Chapter I. Making Compound Telescopes
" II. Flotation Systems for Mirrors
" III. Making Optical Flats
" IV. Making a Sun Spectroscope
" V. Photographing with the Telescope
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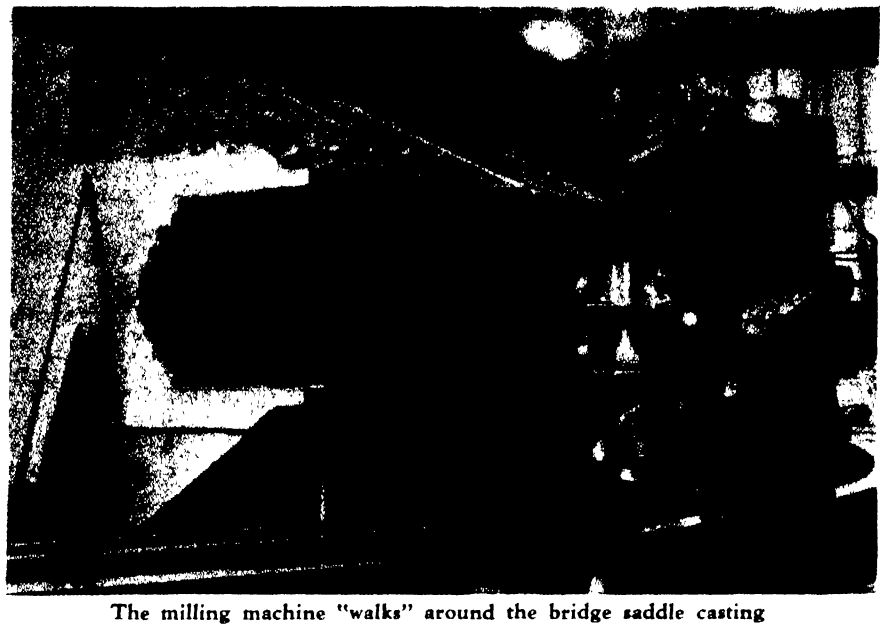


The milling machine "walks" around the bridge saddle casting

more, the rubber is the same as in the beginning, none of its properties having been changed.

A suggested use for these thin slices is necktie linings to prevent wrinkling. (A patent is being taken out on this application.) Another suggestion is as a lining for winter clothing, for the dead air cells are comparable with the air cells in wool. Also it might form a very satisfactory non-slip bottom covering for household objects such as ash trays, flower pots, and the like.

Steel Castings Support Golden Gate Bridge Cables

A VIVID indication of the magnitude of the Golden Gate bridge is provided by the size of the steel castings which are employed to support the cables on the tops of its towers.

Each cable support or saddle consists of three segments bolted together, weighing approximately 150 tons. The maximum metal thickness is seven inches. Their inner grooved surfaces are designed to provide smooth curved supports for the cables.

Mounted on the tops of the towers, the saddles rest on nests of rollers, and in their original position are set shoreward, three to five feet from their final position. As the construction of the suspended portion of bridge structure proceeds, the cables tend to decrease in sag and elongate slightly, with the result that the saddles gradually move bayward as the weight increases, until they are in final position centered on the towers when the structure is completed. In this position the rolls will be "killed" and the saddles fixed or anchored permanently to the tower tops.

These huge castings originated in the steel foundry at the Bethlehem, Pennsylvania plant of the Bethlehem Steel Company, where the casting and rough machining operations were performed. They were finish machined by The Midvale Company.

Two open hearth furnaces were required to provide sufficient steel for these huge castings. The plain carbon steel was teemed from them simultaneously into large ladles, from which it was poured into pit molds that had been arranged for bottom pouring, with nine risers per segment. Following the removal of the risers, the segments were annealed to remove internal stresses, and rough machined at Bethlehem before being shipped to Midvale for finish machining operations.

Toe Out—Toe In—Toe Out

A GENERATION or two ago we were told to toe out, and then a few years later we were told to toe straight ahead "like the Indians." Evidently many took this later advice too literally, for now comes Dr. Dudley Morton, Associate Professor of Anatomy at Columbia University School of Medicine and an authority on the evolution of the feet of man and the apes, and tells us not to take the "Indian foot" walking doctrine quite so seriously as health faddists formerly asserted. In a new book, "The Human Foot," Dr. Morton says that examinations of American youth and African natives concur in demonstrating that a mild degree of out-toeing in walking is predominant in normal and healthy individuals. "The angle tends to vary with each step, according to the circumstances of speed and to the need for lateral stability of the body. From a physiological analysis, a mild degree of out-toeing is to be regarded as the position of greatest efficiency.

"The use of a conspicuous degree of out-toeing—90 degrees—in Continental armies for many generations seems sufficient evidence that even that position is not injurious to a normally designed and balanced foot, in spite of opinions to the contrary.

"In weak and unbalanced feet, however, the wide angle of gait is definitely harmful, being an added source of faulty strain. It is conducive to greater disturbance in the distribution of body weight through the foot, and therefore, to further unbalance and deformity."

Dry-Ice Well Leased by Government

THE Secretary of the Interior has signed the first lease in American history for the operation of a dry-ice well. The well, producing almost pure carbon dioxide, is located in Carbon County, Utah.

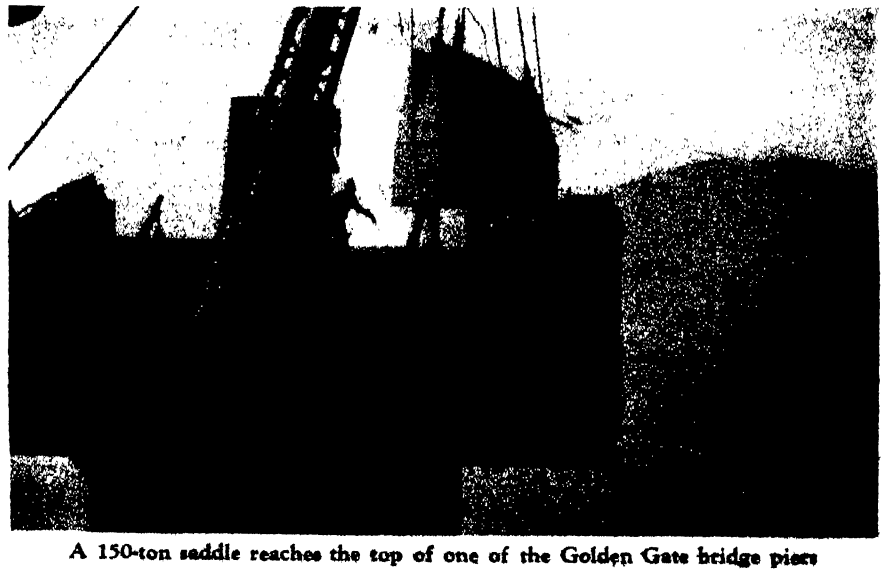
It was first drilled in January, 1924, showing a gas content under terrific pressure of more than 98 percent pure carbon dioxide. At that time there was no known means of utilizing the gas, except locally, so the well was plugged and temporarily abandoned. The lessee, the Farnham Dome Petroleum Company, and the operating company, the Carbon Dioxice and Chemical Company, believe they can work out a means of shipping the carbon dioxide without great loss, either in liquid or solid form.

The computed open flow of the well is 1,600,000 cubic feet per day, but geologists estimate that only 1,000,000 cubic feet per day can be withdrawn, because the release of pressure at the foot of the well will cause about 600,000 cubic feet daily to be frozen in the sands.- *A. E. B.*

No Sahara in Dust-Storm Area

DESPITE the Sahara-like atmosphere they create, the spectacular dust storms of 1934 and 1935 are not a sign that part of the United States is turning into a vast permanent desert, according to Dr. J. W. Humphreys, of the Weather Bureau.

The appearance on this continent of an



A 150-ton saddle reaches the top of one of the Golden Gate bridge piers

expanse of unproductive, drifting sand like that on the eastern hemisphere, Dr. Humphreys says, would call for a complete change in climate on the order of the one that, centuries ago, gave northern Africa its great desert. That change occurred through countless ages as the Europe of today slowly emerged from the ice cap which, for other countless ages, had covered it. With the melting of the ice beneath their northern range, the air currents that govern the earth's weather were shunted into new paths as they flowed south, thus altering Africa's climate.

No such climatic change is imminent in North America so long as the frozen north remains frozen, Dr. Humphreys says. Probably, he adds, the ice there will melt some day, but not for 5000, possibly 10,000, years.

Dust storms in the United States are nothing new. The west has always had them. Until the last two years, however, they have been purely local disturbances. But several years of drought, on top of the reckless denuding of thousands of acres of land where rainfall is normally relatively light, provided, in great abundance, the first ingredient of dust storms. The high winds that blow over the plains in spring and summer brought the second ingredient.

Unfavorable conditions brought about over a long period of years cannot be relieved in a single season. As the program recently adopted by the United States Department of Agriculture to prevent wind erosion of the soil goes into effect, however, dust storms may reasonably be expected to subside. Among other things, this program calls for putting back into grass those lands that never should have been plowed or overgrazed.

New Test for Oils

ONE of the hardest questions to answer has been why two oils almost identical in density, viscosity, and other common physical properties, may differ widely in their lubricating qualities. One cannot tell by any simple physical test, in advance of actual use of the oils, which one will be the better lubricant.

Chemists have discovered that the molecule of a good lubricant consists of a long chain of atoms, so that the molecule has the form of a long, slender filament. These molecules stand on end on a metallic surface, one end adhering firmly to the surface. In this way they pack very closely together, and pressure between two surfaces cannot squeeze them out.

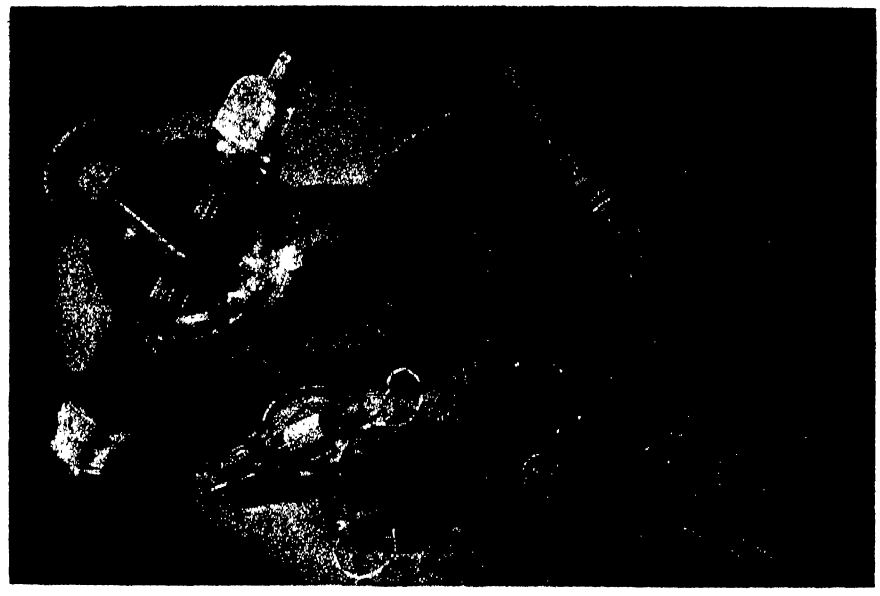
A second layer of oil molecules stands on top of the first layer, another on that, and so on. Two metallic surfaces thus ride on velvety cushions and slide easily on each other.

The longer the filaments, and the more regularly and closely packed they are, the better is the lubricant.

These facts have been disclosed by the use of X rays.

A new mode of testing has been applied by Dr. C. A. Murison and is reported in the *London Philosophical Magazine*. Dr. Murison directs a stream of electrons at a glancing angle at a film of oil and studies the diffraction pattern produced by the reflected electrons. From this he can tell at once the lubricating qualities of the oil. He

(*Please turn to page* 105)



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THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

IN the new edition of "Amateur Telescope Making" Porter points out what he calls the "bottleneck"—that point on the declination axis of a telescope where it joins the tube, and which so many amateur telescope builders make too thin to avoid tube vibration. The neat little telescope shown below—a 4"—made by George Sunal of

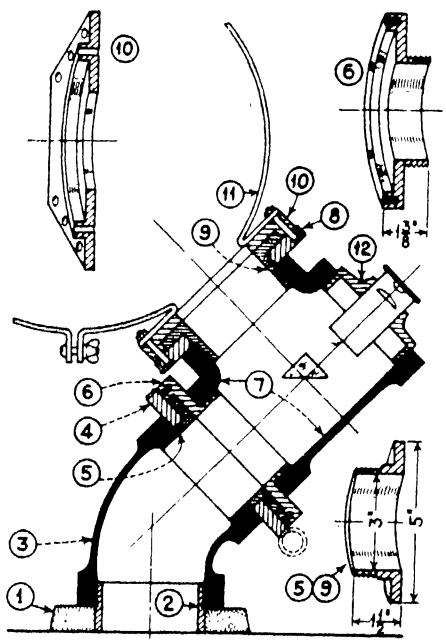
No "bottleneck" here

5046 Eugene Ave., Dearborn, Mich., shows better than usual design at the bottleneck.

The mounting in the center, made by R. S. Danielson, 1711 Ave. N., Galveston, Tex., has a real bull neck in the same place, and is designed all over on the same principle. "Here is a mounting that should be steady in one of our Gulf hurricanes down here on the Texas coast," Danielson writes. Your scribe spent the summer of '16 in that region and lived through two of these Texas hurricanes. Any mounting which will stand up in one of them is sufficiently rigid for astronomical work. This is one of the best adaptations of the Springfield that we have seen. On the drawing, 1 is a concrete pillar, 2 a pillar pipe, 3 a 45° el, 4 the worm driven ring gear, 5 the ring key, 6 the coupling ring, 7 a 3" standard pipe T, 8 the worm driving ring gear, 9 the ring key (identical with 5), 10 the saddle coupling ring, 11 the tube clamps, and 12 a cap (machined to suit). Danielson explains that ring gear 8 can be driven by the worm, or can drive the worm, so that the tube may be moved quickly by hand, but that in the polar axis the worm drives the ring alone. Bearings 4 and 5 are friction. Ring 10 is rectangular, in order that greater spread can be had between the ends of clamps 11. All in all, this is a rugged, close-coupled, commendable mounting.

THE 8" telescope at the bottom of this page was made by Dr. M. N. Duxbury, a Green Bay, Wisc., dentist. There is a phonograph motor drive on the pedestal. Note the declination slow motion control, the handscrew on the tube. One fine feature is the fact that the observer can rotate the tube in order to bring the eye to a desired position, with less exertion than is required in wrestling with a polar bear. "Look closely," Duxbury writes, "and you will see that there is a clearance of ¾" between the basket circles and the tube for the roller bearings. The tube rolls very quietly and smoothly within the basket without loosening the thumbscrews."

IN "A. T. M.," pages 376-379, Hindle's method of plotting the readings in the knife-edge test is shown. The mirror is divided into zones of definite and known widths, and readings of zonal aberration made at those radii are plotted graphically. The purpose is to ascertain the total zonal aberration and whether the curve is paraboloidal. Nicholas M. Smith, Jr., Box 4, Pulaski Heights Station, Little Rock, Ark., uses a similar method, which is helpful in interpreting irregular mirrors whose shadows otherwise puzzle the tyro. But, instead of measuring the zonal aberration at known



The Texas Hurricane mounting

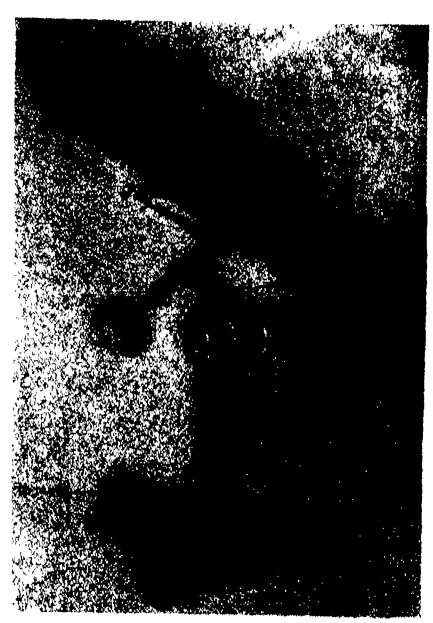
radii, he sets his knife-edge either at random distances from the mirror or at such distances that irregularities on it will be best revealed, and then measures the position of the "crest of the doughnut" at those particular knife-edge settings. Then he lets the mirror plot its own curve on cross-section paper.

"It often happens," he writes, "that the study of the shadow and the measurement of the difference between the radii of curvature of the inside and outside zones are insufficient to give the true nature of the curve—especially to one not too experienced with the various shadows. The only method left, then, is that of making a zonal test, measuring the aberration of the focal point between each zone and the center. This is usually accomplished by placing stops in front of the mirror, that are cut away in the zone to be tested. The knife-edge is adjusted until the two portions are lighted with equal intensity, and this position of the knife-edge is marked as the center of curvature of that zone, and so on, zone by zone—involving a long and laborious process.

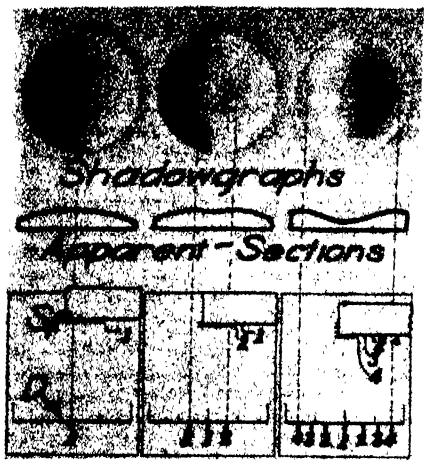
"It once occurred to me, while using the Hindle method of testing, to try a correlative procedure in determining the centers of curvature of various zones of the mirror. This was tried with great success. It was possible to make a full zonal test on an 8-inch, *f*/6 mirror in less than one minute, and all cumbersome stops were dispensed with.

"The method of procedure is this: The knife-edge carrier is provided with the usual straight-edge *S*, in the figure, and a paper is thumb-tacked to the table under it. A line *D*, representing the diameter of the mirror, is drawn on the paper, and divided into quarters. The knife-edge is first placed inside the center of curvature of the inside zone (or zone having the shortest radius of curvature) and brought back toward the eye until it stands just at the center of curvature of that zone, as indicated by the uniformity of the shadow at that area (illustrated in the first shadow-graph). A line is then drawn along the straight-edge and numbered '1'. Along the representative diameter at the bottom of the paper, the place on the diameter having this radius of curvature, by eye estimate, is indicated and numbered '1'.

"The knife-edge is then moved slightly back, a line is drawn along the straight-edge and numbered '2'. The position of the crest of the apparent bulge of the mirror is judged, and the corresponding positions are marked on the line representing the diameter, as shown in the second and third shadow-graphs. [A stick of wood bearing



Dr. Duxbury's ritzy job

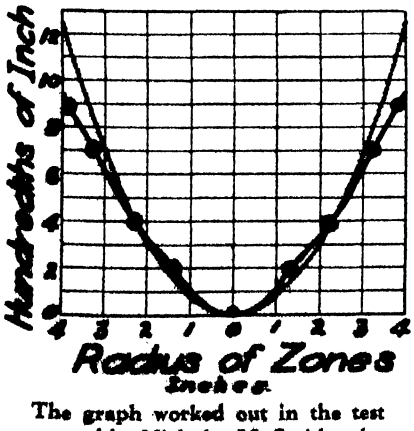


Nicholas M. Smith's test

pins at measured intervals (Everest's method) or a strip of metal having teeth filed at the same intervals (Mason's method) may be supported in front of the mirror, and will help in estimating the different radii.—*Ed.*] The process is continued in as many steps as desired, and from these data—the aberration of the light and the corresponding positions on the mirror—a graph can be drawn and compared with the ideal curve, as calculated from the r^2/R values. This graph is of little use in ascertaining the proper procedure for the correction of a badly shaped mirror, but a comparison of the graphs before and after a spell of polishing does show quite clearly the changes brought about—changes that are otherwise imperceptible.

"It was found unexpectedly easy to determine the portions of the mirror that were lighted with equal intensity—much easier, in fact, than trying to set the knife-edge so that any two given portions would be lighted equally, as when using stops."

In his letter, Smith also stated that he could see the typical knife-edge shadows without the knife-edge, by using the edge of the iris of the eye as the knife-edge. This was tried out and found to be correct; you get the shadows splendidly after spending about three minutes jockeying around and trying to give your head a filar microscope adjustment with nothing but your neck muscles. For several days, after wringing our neck in the attempt to catch the shadows, we went around with a neckful of grandpa's rheumatiz, but the stunt is fun—well, anyway, once. Incidentally the various cobwebby effects which wander over the cornea and are known to physio-



The graph worked out in the test as used by Nicholas M. Smith, who also furnished the drawing at top

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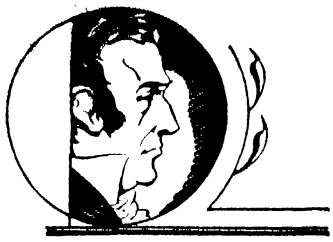

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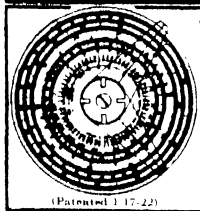

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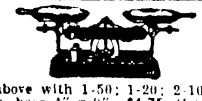

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AT the right are several drawings done by our artist, J. F. Odenbach, after rough sketches by Ellsworth L. Martinelli, Box 402, Colfax, Calif., whose technic for HCF work they describe. In this technic the mirror is polished on HCF on glass. Then a tissue disk is laid on it, this is wetted, painstakingly adjusted and smoothed, and a plaster tool is cast (Fig. 1). The moist tissue is next rubbed off with the palm, taking pains that the plaster is entirely undamaged.

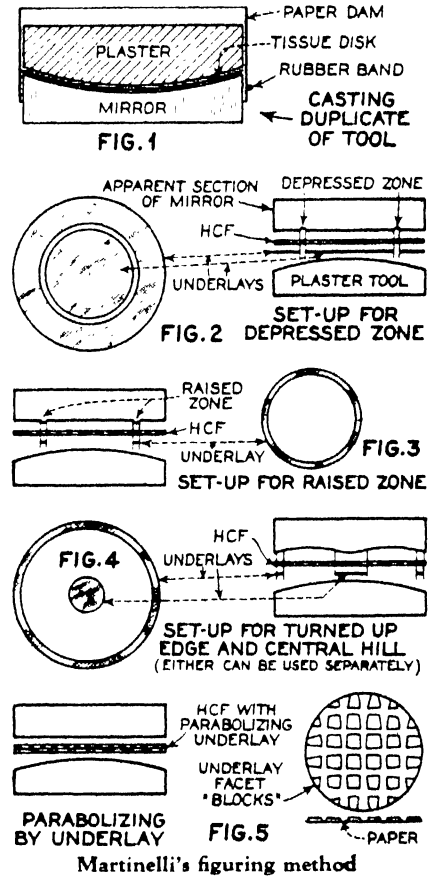
Figs. 2 and 3 show how underlays of light, unglazed card of about the weight of U. S. postal cards are inserted between tool and HCF, wherever a zone needs treatment. Cut the paper with a sharp knife, to avoid an edge burr.

Parabolizing is done as shown in Fig. 5. The layout is made on paper, transferred to cardboard heavier than that mentioned above, by means of carbon paper, the blocks are cut out and fastened to the original layout pattern with shellac and dried under weight. This makes another underlay for an HCF disk. Cold press and parabolize on it.

The above is an abstract, necessarily sketchy, of a 2300-word paper by Mr. Martinelli, but the figures show most of the data. The original paper will be lent to those who request it. In this paper the author frequently commented on the difficulty of using the HCF strip-and-patch technic, stating, as others have stated, that it leaves irregularities and depressed places at the edges of the strips. This is often true, at least the first time it is tried. But the user soon learns to avoid this by frequently shifting the strips, changing the stroke, mixing in some side motion or else toeing the strips in, to distribute the abrasion; and, in general, finessing. One can pick up the mirror with strips adherent to it, slide them over a hair or two, lay it down and go on working, much faster than one can potter with more precise substitutes. After mussing up about two initial attempts, the technic of removing a raised zone, and then removing every visible trace of its leavings, is soon learned. The matter of using measuring rods, dividers and so on, for spotting zonal locations, may be forgotten if the estimate powers of the eye are used. In short, the method soon becomes one of feeling and intuition and, after that, it is so direct and free from complication that it beats a more exact, more rational, but more complex method.

THE most expert workers seem to get scratches, while some of us who wish we were as expert can't seem to get them, even when we try hard. How they come is one of those impenetrable puzzles—the scratchees say they take every known step to avoid them. This note from Hindle may explain some of them—though it is improbable that any one cause may be assigned to all cases or even a majority of cases. "Scratches during polishing are almost invariably due to filthy polishers. The rouge is allowed to dry on, and hardens; the polisher changes shape slightly and when next applied is resting on some of those hard points which cut into the polished surface, showing which way the polisher moved. When polishing is suspended, the polisher should be scrubbed down with a strong scrubbing brush, and plenty of water. Pay special attention to the grooves, and continue so long as any color comes off. Pour warm water, 100°-120° F., over the surface of the polisher before putting it on again to the rouged surface of mirror."

HERE is James L. Russell, lawyer, 318 Chester-Twelfth Bldg., Cleveland, Ohio, reporting what he calls a coo-coo idea: "If you can not get the mirror and



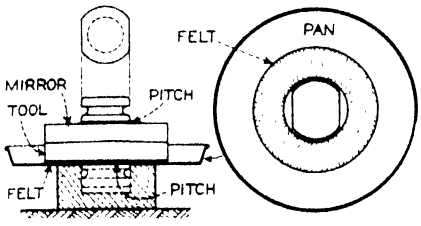
Martinelli's figuring method

the prism and the eyepiece in line try this. Set her up in full moonlight and point the tube toward the moon. Then blow a good puff of cigaret smoke down the tube. You will then see the cone of light coming off the mirror, and it will look so real that you can nearly cut it with a knife. The cone hits the prism and bounces right up into the eyepiece. Move the scope a little off and the cone will then miss the prism and it will project out of the end of the tube. It will go from the mirror to a point and then from the point it will again get large. It is a most beautiful sight." This idea isn't coo-coo, but should be added to the data in "A.T.M.," pages 381-382. As Russell writes, the idea in general is old—see top of page 390, for example. But it is a good one.

LIEUT.-COL. Kendrick, U. S. Army, Retired, Jacksonville, Fla., writes R. W. Porter, with regard to testing pitch by biting it, that when he first took up the TN hobby a friend of his, Dr. S., did the biting, as follows: "Took some hot pitch—a piece as big as a thumb—dropped it in a glass of water, removed it and bit squarely into it. His teeth stuck solid. I grabbed a bottle of turps, pried open his lips and went to work. It blistered his mouth, and I finally had to get some gasoline before

I could get him unstuck." Pitch should be bitten in a gingerly, ladylike manner, not like Navy Cut Plug. Just try to imagine this colonel and the doctor—the one wildly running around, the other wildly gesticulating—in the described predicament! Maybe the joke was about 50-50, all in all.

G. MERRILL, U. S. N. Hospital, Annapolis, Md., writes via John Pierce that he made his mirror in a morgue, which he claims is a record, and who will want to tie it! The traditional marble slab served as the test table and was steady as a dead man, while temperature conditions were fine. "Working till 1 A.M. was not



The lazy mirror maker's delight

bad," he comments, "once you got used to the environment." Can anyone beat that place as an odd workshop? Well, perhaps we can. We have learned that a certain telescope maker in Minneapolis (name will *not* be furnished on request) found himself inadvertently serving a term in jail, became bored and asked a confrère—confrère, that is, in telescope making—to bring his mirror making outfit to the jail, and turned out an A No. 1 mirror there. File this idea for possible future use.

THE above drawing represents a sitting-down grinding and polishing rig, and was drawn by Odenbach, from a life-sized model sent us by the designer, E. B. McCartney of 76 Roslyn Road, Mineola, N. Y. He calls it his "Invertible, Sit-downable, Synchromesh Grinding and Polishing Dingbat," and our brief preliminary test of it speaks loudly in its praise. The shaded part represents a plank which is to be clamped to a table or bench. Turning the rim of the pan turns the tool, the hole in the pan being shaped to the plan of the wooden knobs, in order to key the two together. McCartney belongs to the Long Island Amateur Telescope Makers' Club, a group which, like the Telescope Makers of Springfield, requires *completion* of a telescope before considering grant of membership. This club, inadvertently omitted from the new list of clubs in "A.T.M.," fourth edition, should be added to that list. Your scribe, who is getting fat and lazy, will use McCartney's patent dingbat on his next job, and remain seated. Somebody please think up one that can be used from a hammock.

Mathematics hounds may find interest in the following books which have been published: "The Calculation of the Orbits of Asteroids and Comets," 1934, by Kenneth P. Williams. Also "Planetary Theory," 1933, by Brown and Shook. Both are about the methods for the calculation of the general orbit of a planet, and for most mere mortals they will seem deep, deep, deep. A fine new German astronomy textbook, entitled "Astronomie," by Oswald Thomas, has recently appeared. It covers general astronomy—has fine cuts.

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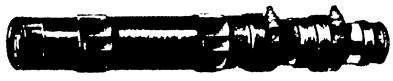

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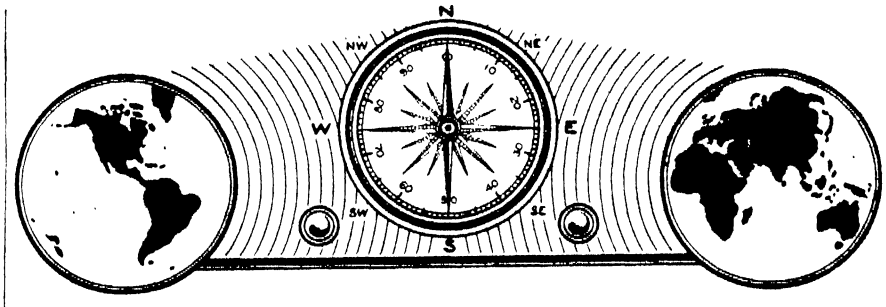


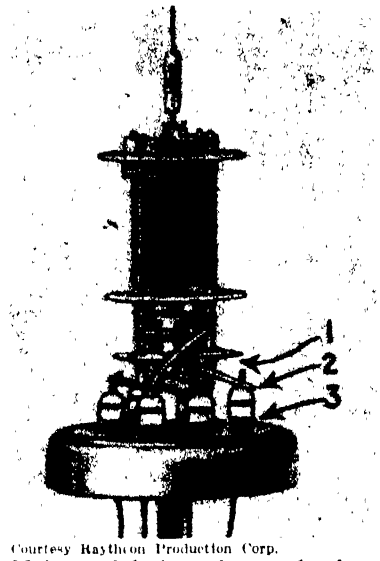
WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

Metal Tubes Here to Stay

THE all-metal tube has marched right up to the front line. Since its introduction some months ago, it has been improved in a number of ways. Most manufacturers of metal tubes have eliminated possible leakage by brazing the junctions between the Furnico eyelets, through which the connecting leads pass, and the metal support base.

Some difficulty was experienced in the early stages of metal-tube manufacture due to small particles of the "getter" material landing on the glass beads which insulate the element leads from the eyelets. Though metal shields were and are still used to prevent the vaporized "getter" from reaching the glass beads and the mica insulating spacer located near the base of the tube, some vapor still manages to condense on these points of insulation. Leakage paths are thus introduced, which cause the tube to become noisy.



Courtesy Raytheon Production Corp.

Noise and leakage in metal tubes are eliminated by spraying the insulating beads (2) and the mica spacer (1) with a liquid ceramic. Tube leakage is prevented by brazing the Furnico junctions at (3)

This problem has been solved by spraying both the glass insulating beads and the mica spacer support with a liquid ceramic. The result is a rough insulating surface which, if magnified, would appear like groups of mountain ranges, with deep valleys. Because of this highly uneven surface, such particles of "getter" as may condense on the glass beads and the mica element support can do so only on the "mountain peaks." There is, in consequence, no continuous conduction path for electrical currents, as the conductive "getter" particles are unable to bridge the peaks.

Control-grid losses, due to leakage and high input capacity, have been reduced considerably through the use of a new type of phenolic insulation material. Small disks of this material are used in such tubes as have the control-grid connection at the top. The disk insulates the grid cap from the top of the metal shell, and reduces losses where it is most important to have them reduced—at the input, where the signal voltages are very small to begin with.

The result of these and other improvements is that all-metal tubes, designed to have electrical characteristics practically identical to those of the glass-type tube, are showing superior qualities in receiver circuits. Moreover, now that receiver design engineers have a better acquaintance with the metal tube, it is being used more effectively in all-wave receiver circuits. Slight alterations in the values of resistors and other changes have brought forth far superior results. For instance, bucking bias voltages, caused by gas current, have been eliminated in the receiver circuit with a resultant increase in over-all sensitivity.

Mysterious Interference

AT the time of this writing, there is a peculiar form of interference in the short-wave bands. It is an unkeyed (continuous) carrier, presumably modulated by 60-cycle alternating current. It appears at three different frequencies simultaneously and shifts about 100 kilocycles every three minutes. It may be heard most any time between the hours of 9 A.M. and 9 P.M.

This interfering carrier has been reported between the frequencies of 8 and 25 megacycles by the United States Army and Navy, RCA Communications, the A.T. and T., and by the airway radio stations. It is heard with equal strength in England and the United States, although the carrier is weak on the West Coast.

The writer has heard the same signal at frequencies as high as 30 megacycles, and it may extend further.

There is no question but that there is intelligence guiding the carrier, but for what purpose? And who may it be? It brings forth memories of the German radio

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

barrage transmissions during the World War. The theory has also been advanced that the interference may emanate from a new type of diathermy machine now in use.

"Queen Mary's" Radio Equipment

THE *Queen Mary*, new Cunard White Star superliner, will make use of a total of 32 different wavelengths; 11 for short wave, 9 for radio telephony, 7 for long wave and 5 for medium wave.

The use of different wavebands will make it possible to send and receive several messages simultaneously and also allow two ship-to-shore conversations at the same time, one to Europe and one to the United States.

For the operation of these wavelengths there will be at least nine separate aerial systems.

I-F Interference

INTERFERENCE from a code station which may be heard over the complete dial range does not indicate inadequate receiver selectivity. This form of interference is due to a code signal riding through the intermediate-frequency amplifier. This is possible when the wavelength or frequency of the code station is the same as, or close to, the wavelength or frequency to which the i-f amplifier is tuned.

This form of interference may be eliminated by inserting a wave-trap in series with the aerial lead-in wire. The trap should be tuned to the same frequency as the interfering signal.

Tube-for-Tube Comparisons

IT is interesting to observe that it is not possible to compare "metal" and "glass" receivers tube-for-tube. This is well worth remembering when you make a purchase.

In *all* metal-tube receivers manufactured up to the present, the diodes used for detection and automatic volume control are in a separate tube (the 6H6), whereas in receivers using glass tubes, the diodes are combined with a triode or pentode audio-frequency amplifier in a single envelope. In other words, in the metal-tube receiver, detection and automatic volume control are provided by one tube and audio amplification by another tube, while in the glass-tube receiver these three functions are handled by a single tube.

Thus a receiver employing *six* glass tubes is the equivalent of a receiver using *seven* metal tubes. Consequently, don't let a radio dealer tell you that a set with six glass tubes is superior to a set with six metal tubes—the comparison is not a fair one.

All-Wave Selectivity

THE 31- and 49-meter short-wave international broadcast bands, as well as the 20-, 75-, and 160-meter amateur 'phone bands, are so overcrowded that interference between stations is the rule rather than the exception.

The average all-wave receiver cannot cope with the situation. The only possibility of separating the stations in these bands is by the use of a crystal filter in the intermediate-frequency amplifier, or by the use of regeneration in the radio-frequency and/or intermediate-frequency stage. Even then, complete separation of all stations cannot be expected.

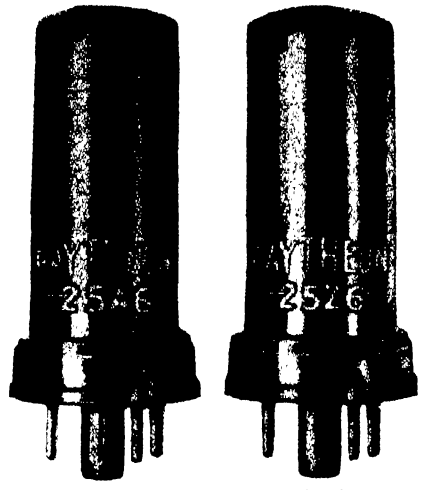
However, the use of regeneration or a crystal filter for increasing receiver selectivity to the maximum point will work wonders, but not without a sacrifice of quality. If the maximum selectivity of a crystal filter is used, voices are quite often unintelligible and music is deprived of its higher tones.

Neither regeneration or a crystal filter are to be recommended if quality reception is desired, but for the hunter of distant stations who cares not if voice and music are damaged by ultra-selectivity, either system will prove to advantage.

Practically all of the latest amateur receivers employ crystal filters; a few use regeneration instead.

New Metal Tubes

FIVE new all-metal tubes have been introduced recently. Four of these have glass counterparts, but the fifth is a distinctly new type. The 6Q7 is of particular interest, as it is the first tube in the metal line having diode plates combined with another tube section. To be specific, it is a



Two of the newest metal tubes

duo-diode triode, similar to the types 55 and 75 in the glass line.

The 0Z4, which has no filament whatsoever, is a rectifier of the gaseous conduction type. It is designed for use as a high-voltage rectifier in the power-supply unit of an auto-radio receiver. Since no filament current is required for this tube, there is less drain on the car battery.

A full-wave rectifier of the heater type has also been announced. It is the type 6X5, and is somewhat similar to the type 84 high-voltage rectifier in the glass line. The 6X5 is adaptable to the smaller a-c operated home receivers and to auto-radio sets—for use, of course, in the power supply.

The last two tubes recently announced are designed for use in small receivers of the a-c d-c combination type. The first is a power amplifier pentode, type 25A6, which has a 25-volt heater that may be connected in series with the other heaters in the set. The second is the 25Z6, which also has a 25-volt heater. This tube is a double half-wave rectifier, similar to the 25Z5 in the glass line. It may be used as a double half-wave rectifier or as a rectifier-voltage doubler.

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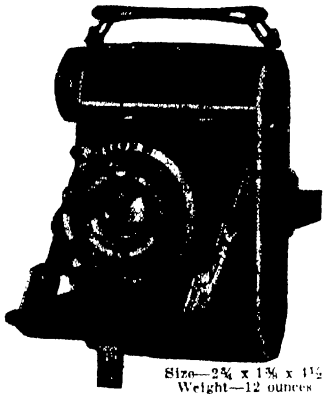

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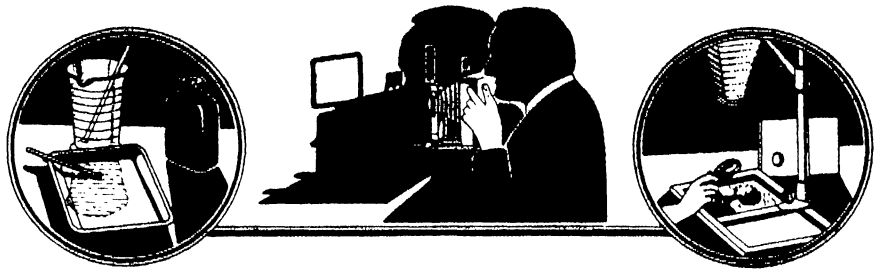


CAMERA ANGLES

Conducted by JACOB DESCHIN

Photographic Caricature

THERE is distortion and distortion. Offhand its connotation is bad, but there are times when it is to be embraced as a definite aid in serious (or otherwise) photographic maneuvers.

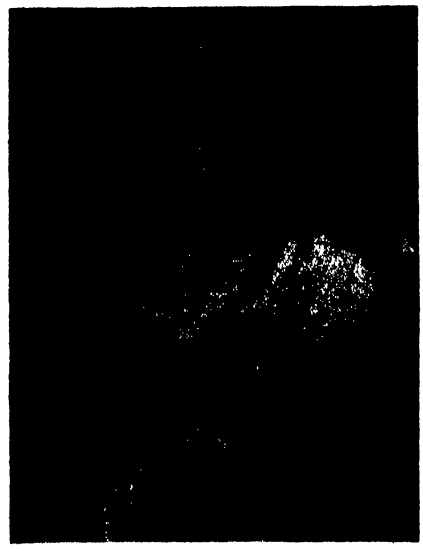
Take photographic caricature, for example, but take it with a smile, or all your efforts will be in vain. A caricature, of course, may be made in the original exposure. That is, exaggerated foreshortening of a foot, whose owner's head, seemingly a mile off, is the size of a pea, or a "shot" from above a standing figure, showing the legs tapering down to the apparent size of toothpicks. But the caricature by distortion of which we shall speak here is that which is obtained from an ordinary negative projected from an enlarger.

Above: **An enlargement made as usual, and,** ***at right,*** **in caricature**

Quite a variety of "trick-mirror" effects of family members and friends may be obtained in this manner. Whether or not they remain friends after seeing your handiwork depends, of course, on their sense of humor, but we must not forget also how much will rest on the manner in which you execute the job.

Distortion is had by tilting the enlarging easel, resting the easel on some firm support during the exposure. Tilting may be slight or it may be so extreme as to place the easel almost parallel with the beam of light coming through the enlarger lens. The support in the first case will be a simple enough matter, but in extreme cases more elaborate arrangements will be necessary. The darkroom worker accustomed to devising makeshifts for temporary matters will know what to do.

The first step, of course, is to insert the negative and project it, tilting the easel at various degrees of elevation, both horizontally and vertically. It will be found that at extreme elevations there will be a noticeable narrowing down of the image at that end of the easel that is nearest the lens. This obstacle in "framing" the picture is overcome by raising the enlarger housing in order to enlarge the picture area. High elevations of the easel will mean that the part of the easel nearer the lens will be better lighted than the lower part. This calls for a difference in exposure time for the two areas in order to get uniformity of tone over the entire picture. Test strips are made at the top and bottom, the latter being given more exposure by means of "dodging." Another precaution to take is to make sure that the paper is placed on the easel (thumb tacks will do for this purpose) without moving the easel on which the image has been previously focused. To make sure on this point, use the red or orange filter on the enlarger, although the regular medium yellow filter will serve on lenses which are used in both the taking and the projecting cameras. Also, the lens will have to be stopped down considerably in order to get over-all sharpness.



A few trials will convince the experienced worker of the enormous possibilities of this phase of photographic endeavor. He will find that this medium will permit not only of fun-provoking exaggerations but may also be used by means of slight tilting to give a personal interpretation of the sub-

ject which is not possible with a straight "shot."

Incidentally, pictures involving straight lines which did not come out straight because the building or what-not was high and the camera had to be tilted upward may, within reason, be corrected under the enlarger by a tilt of the easel in the opposite direction. Obviously, this will not work in extreme cases but when feasible should be a very valuable "dodge" indeed.

Photo-Electric Exposure Meter

THE public demand for reliable exposure meters has brought several new products on the market, the latest of which is the photo-electric Photoscop, hitherto round in shape with a circular lens "eye" in its center, and now brought forth in rectangular form somewhat resembling a package of cigarettes, although slightly longer. But most important of all is the new Photoscop's original mechanical design. At one end of the meter, the body of which is of Bakelite, is a flat, narrow lens extending, for half the case's depth, from edge to edge of the meter's width and placed at an angle. The other half of the lens arrangement, also extending the full width of the meter, is a mirror. The general construction of the lens-mirror feature is that of a long triangular trough, the apex of which cuts into the end of the meter. Acting as a sort of "sunshade" as well as serving the equally practical purpose of limiting the field of the lens' vision to the usual 45 or 50 degrees, is an open-end box-like arrangement extending from the end of the meter and slightly beyond the limits of the lens and mirror.

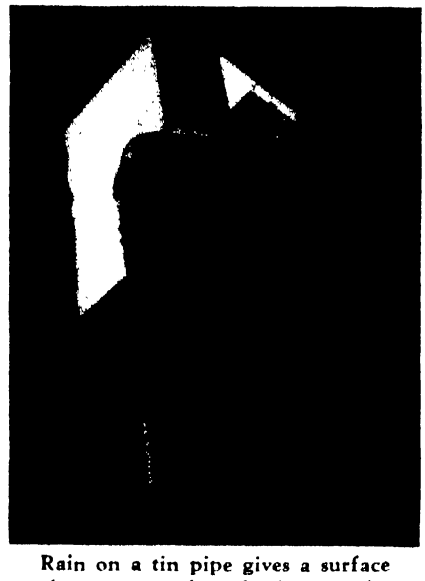
As explained to the conductor of this department in an exclusive interview in advance of placing the instrument on the market and before minor details had been definitely decided upon, the mirror feature is included principally for pictures in which the sky is to be included. The lighting from the sky strikes the mirror and is reflected to the lens, thus affording a more correct general reading than might otherwise be possible, since the sky light as reflected from the mirror will not be as strong as it would be if the meter were pointed directly at the sky. The resultant reading is thus more nearly accurate for the entire scene generally.

Another useful feature of the new meter is an arrangement whereby readings are made direct instead of first observing the reading and then making the calculations on a disk. An arrow is set on the exposure speed desired and another on the speed of the emulsion being used. When the meter is "aimed" the usual needle indicates the "F" stop to be used. The meter has scales for both still and motion picture cameras.

Many advanced amateurs, having tried them all and found one film emulsion best suited to their purposes, may never have to change the emulsion speed, unless they follow the desirable practice of using a slower, and therefore better contrast, film outdoors, and a faster one indoors when taking "candid" and other indoor type of pictures under relatively poor lighting conditions. Setting the exposure speed has also been found advantageous by some seasoned workers. Extreme cases are those of the man who never makes a picture except at a full second, varying his lens openings to suit the light conditions, and another man, who likes wire sharpness over the entire field and stops his lens way down when outdoors even if it means shooting at 1/20th of a second in broad sunlight.

Surfaces

MANY photographers find a delight in subjects merely because of their striking surface appearance. Subjects which they would not consider worth a second glance are raised to the level of artistic possibilities by the mere fact that at a certain time of day or night, or because of the magic effect



Rain on a tin pipe gives a surface character worthy of photography

of rain or sleet, commonplace objects are made to look extraordinarily attractive. The illustration shows what rain will do.

In late afternoon, a little while before the sun starts to retire, watch people's faces, the sides of buildings and other objects as they catch the slanting rays of the sun. The warmth and beauty of the texture of objects thus revealed is a lovely sight. At night, in some lonely street, you may find the gleam of trolley tracks and cobbles glowing under the street lamps or a shingled rooftop illuminated by a full moon one of the rare experiences of your photographic career.

Your camera, whatever it may be, accompanied by a good exposure meter, and—in late afternoon, early morning, and at night—a sturdy tripod, together with the indispensable "seeing eye" are all the equipment you need.

Others' Mistakes

WHILE it may be little solace to a man to know that someone else has made mistakes as bad as or worse than his, there is an undoubted value in hearing stories about the mistakes of others, however ludicrous those mistakes may have been. It teaches a man humility and an appreciation of the fact that no matter how far advanced he may be in the photographic game he must never lose sight of the necessity for careful adherence to the mechanical details.

There is the story of a professional photographer who was sent on a distant assignment to do a series of photographs for a client, the latter standing the expense of

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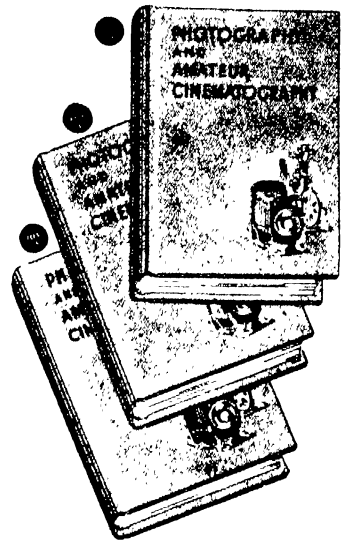

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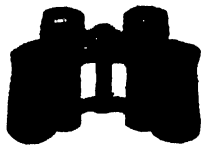

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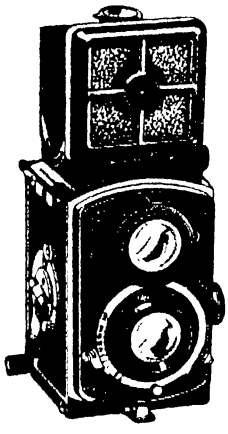

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the trip. The photographer exposed three filmpacks during the course of the day and felt he had done a good job. The awakening came when he returned to his darkroom and found all three dozen films developed out without a dot on any of them, all because he had forgotten to pull the slide. Needless to say, he had to return another day, this time at his own expense, and retake the whole business.

Another professional, getting acquainted with a new flashing gadget on his camera, recently took a bunch of photoflash pictures at a horse show and pulled a blank every time (as the darkroom aftermath indicated) simply because he forgot to set his shutter before each exposure. Result: An evening wasted, cost of photoflash bulbs and film irretrievably gone, and a cluster of picture-taking opportunities snatched away forever.

A prize boner is one pulled by a newsphotographer who left his lens behind when rushing off to an assignment, his paper's policy being to keep lenses locked up in a safe overnight. Another involves an advanced amateur who took so long composing a waterfront picture silhouetting a boat against the lowering sky that the boat started moving away just as he was about to start his time exposure.

Low-Priced Miniature

"MINIATURE" photography for the many appears to have arrived with the entry into this field of the Argus Miniature, based on higher-priced models and capable, according to the manufacturers, "of night, theater, indoor, candid and color photography," but costing, more or less, an office boy's week's earnings. While the lens, in this age of superspeed objectives, is considered "slow," being $f/4.5$, with shutter speeds ranging from 1/25th of a second to 1/200th, it is a triple anastigmat. The camera takes the regular daylight-loading 36-exposure 35-mm film rolls, has a visible automatic exposure counter, an arrangement for automatic focusing, eye level view finder of optical glass, and is offered in a variety of Bakelite cases, in black with chromium trim and, in the de luxe models, in gray and gun metal, in ivory and gold, and in brown and gold. A vertical enlarging outfit utilizes the camera—lens, body and all—the enlarger proper consisting of housing, standard, and easel. Enlargements may be made up to 8 by 10 inches. Placed horizontally, this enlarger may also be used as a projector for black and white or color projection on a viewing screen placed over the easel.

Stirring Rods

IT may be an immediate economy to have but a single stirring rod for both developer and hypo mixing, but in the long run one may pay very dearly for such parsimony. We all know how little hypo it takes to spoil the developing solution, so why take chances? Lightweight stirring rods are now distributed under the name "Safetee" in three colors, white, red and black, the first for the rinsing bath, the second for hypo, and the third for the developer. These rods are described as "acid-proof, waterproof, chemical-proof, tough and durable." The set of three sells for approximately the price of admission to a good movie.

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(*Continued from page 95*)

found for one thing that oils of high molecular weight are superior.

Electron diffraction, it may be remembered, was discovered by Drs. C. J. Davisson and L. H. Germer of the Bell Telephone Laboratories in 1927, and demonstrated the wave properties of electrons predicted by Duc Louis De Broglie and Prof. E. Schrödinger.

An answer is thus given to those who want to know what is the use of all these recondite researches into atoms and electrons, for here is an application of great practical value. Doubtless many important applications will be found, as time goes on, for the scientific knowledge now piling up so rapidly.—*Science Service.*

AIRPLANES OF PLASTIC MATERIALS?

IN the last few years there has been a rapid trend to the complete metallization of the airplane. Wood and plywood are easy and cheap to work and have a good strength/weight ratio. But they are affected by continuous exposure to weather; they are inflammable, absorb water readily, and are liable to shrinkage and decay. The use of metal introduces the problem of corrosion, the expense of a multiplicity of rivets, the difficulty of local weakness in very thin metal covering, and the aerodynamic drag of exposed rivet heads.

Is it possible that quite different materials, plastics, will have their day in airplane construction? "Plastics" is the modern name given to synthetic materials consisting of artificial resins, with or without a suitable filler, and now well known under such trade names as Bakelite, Xylonite, Micarta, and so on. These materials have an enormous number of applications in every industry. In aircraft, Micarta propellers have been used very successfully, and both Bakelite and Micarta are used for aircraft instrument panels, pulleys, ball-bearing housings, and other parts.

The best plastic consists preferably of resin impregnated paper, rather than fabric. The paper is thoroughly impregnated with the solution of phenol-formaldehyde resin, dried and cut to size. The sheets are stacked up to the thickness required, then baked in steam-heated hydraulic presses. Then the sheets are made up into tubes by rolling the impregnated paper on a hot steel mandrel between hot rolls until the required thickness of wall is built up. The product is then pressed in steel moulds or dies.

Rods and bars can be similarly made up by using a thin wire instead of a mandrel. In fact there is no limit to the size and variety of forms which can be obtained in this manner. Ribs, spars, longerons, skin, or covering—all the component elements of an airplane have been produced in England in experimental form. While metal rivets and bolts have been used for connecting up parts, cold gluing has also proved effective for fastening elements together.

Comparisons of strength/weight ratios with wood or metal are not so favorable as

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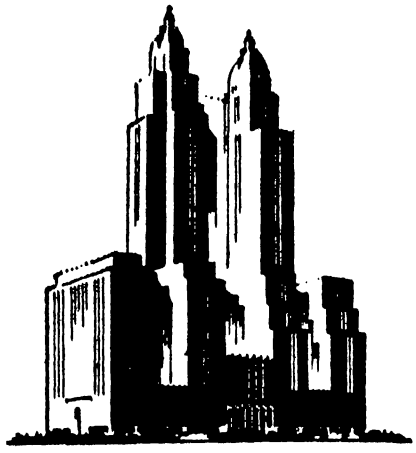

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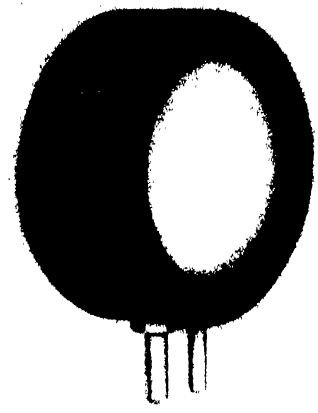
yet, but progress is very rapid. In fatigue, plastics are as yet not as satisfactory as wood.

With a little imagination we can see vast possibilities in these materials for the production of a cheap and durable airplane. Could not a whole fuselage, for example, be produced of a single, very cheap plastic moulding? According to Marcus Langley, writing in *The Aeroplane*, considerable research is being undertaken in the use of plastics for aircraft. These materials are derived from coal. For Great Britain, with its vast and troublesome coal industry, the prospect of building airplanes as a derivative of the "black diamond" is particularly enticing.—*A. K.*

High-Output Photronic Cell

A PHOTO-ELECTRIC cell of the "dry-plate" type which provides an increased current output has just been put on the market by the Weston Electrical Instrument Corporation. It is intended primarily for use at levels of illumination so low that



Compact, high-output photo cell

the regular photronic cell will not provide sufficient output for the purposes intended.

Current output of the new cell is approximately three times that of the regular photronic cell for the same illumination. Its spectral sensitivity is slightly greater in the blue end of the spectrum than that of the regular cell. In common with all known super-sensitized photo-electric cells, the new cell is not quite so stable as the regular type, but it will be found suitable where high output is more essential than strict permanence, especially for use in relatively low illumination.

Monkey Malaria Fights Paresis

MONKEY malaria has been successfully used for treating general paresis, the distressing mental illness which is an end-result of syphilis. For certain cases, at least, this latest method of relieving an age-old scourge may prove to be better than infecting the patients with strains of human malaria, as has been done so widely and usefully since the chance discovery of this treatment in 1920 by Prof. Wagner von Jauregg in Vienna.

The new method has been developed by Dr. C. E. van Rooyen, Halley Stewart Research Fellow at the University of Edinburgh, and Dr. G. R. Pile, senior assistant

medical officer to the Midlothian and Peebles Asylum. They report the results of their research work to the *British Medical Journal*.

One of the chief advantages is that the monkey infection can be made more easily available than the human, since by suitable treatment a monkey can be kept in an infective condition for at least six months and in a laboratory close to centers of population which may be far distant from sufferers from human malaria. Other advantages are the comparatively short period of incubation with the monkey infection, the gentle onset of fever with this disease, and the particular ease with which the fever can be terminated with quinine.—*Science Service.*

Waterproof Lime

RECENT new chemical developments in the building trade include waterproof lime, a processed lime with which may be made a water repellent mortar that protects masonry against leaking. This process of the Rockland-Rockport Lime Company is described by George B. Wood in *Industrial and Engineering Chemistry.*—*A. E. B.*

RADIUM

THE Joachimsthal region of Czechoslovakia is celebrating the extraction of radium there just 40 years ago. This calls to mind the fact that in that time just 100 grams have been produced, the average yield at present being just three grams per year. The yield, however, can be increased upon demand to eight grams yearly.

Movie History

IT is commonly granted that the motion picture is important not only for its pervasive social effect but because it is one of the two most lively contemporary arts and the only new art-form of modern times. Unfortunately, films themselves are singularly evanescent. Of course, certain celebrated pictures enjoy a life long in comparison to the brief existence of the average screen production. Short versions of *The Cabinet of Dr. Caligari* and of *Potemkin*, for example, have been visible occasionally during the past year and *It Happened One Night* has not yet vanished totally. Generally speaking, however, a film two years old is a film which will not be seen again, and the situation is comparable with that which would be created in the world of literature if only those books published within the past 12 months were available. Amateurs of the films and the film-makers alike are consequently confined for purposes of study to what is strictly current. There is almost no opportunity to refer back, to compare, to trace progress or retrogression. It is possible to read about the work of pioneers like the Frenchman George Melies, about the startling innovations of D. W. Griffith and of the post-war German producers: but not to see their work.

In order to remedy this situation, The Museum of Modern Art Film Library has been established for the purpose of collecting and preserving outstanding motion pic-

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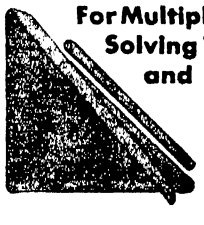

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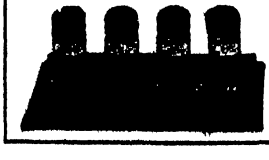

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tures of all types and of making them available to colleges and museums, thus to render possible for the first time a considered study of the film as art. Already two preliminary programs are available for circulation, the first of these covering motion pictures in America from 1895 to 1932; and the second from 1896 to 1934.

All of the series of films assembled by the Film Library will be arranged primarily to afford the student for the first time an accurate perspective of the history and esthetic development of the motion picture since 1894. For example, in the first series the primitive American film is succeeded by the great creative work of Griffith, Ince, and Sennett; but the former includes work of the pioneer Frenchman, George Melies, since it exercised considerable influence on the native product.

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A CHEMICAL "slip-sheet" which promises to be a boon to the printing trade, enabling increased press speeds up to 40 percent, is announced by *Solvent News*. The ordinary "slip-sheet" is a piece of paper that the printing press operator inserts, by hand, between printed sheets as they come off the press, in order that the wet ink will not smudge the back of the next sheet. Now a chemical spray has been developed which covers each printed sheet with a microscopic film that accomplishes the same result, eliminating the hand feeding and speeding up the printing operation.

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CADET DAYS OF WILL ROGERS is a beautifully presented little book which touches upon certain phases of the early school days of Will Rogers which have not been generally brought to light by his biographers. *Kemper Military School, Boonville, Missouri.—10 cents.*

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NEW STUDIES OF SHIP MOTION by P. R. Bassett, Visitor, and F. P. Hodgkinson, Member, is a reprint of a paper read before the Society of Naval Architects and Marine Engineers. It is an engineering treatise on the subject and also deals briefly with mechanical stabilization. *Write for Bulletin 236D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE MUNICIPAL SMOKE PROBLEM, by H. B. Meller and L. B. Sisson, is a brief treatise on the products of combustion of fuel and their effects. The booklet is comprehensive in scope and contains information and advice regarding combustion equipment, the selection of fuel, and the best method of burning it to secure efficiency and practical smokelessness. *Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pennsylvania. Gratis.*

EVIDENCE OF EARLY MAN IN NORTH AMERICA, by Edgar B. Howard. A 170-page illustrated monograph on the Folsom and Yuma cultures and, in general, the chief finds of recent years, tending to show that man has been in America 10,000 years. *The University Museum, University of Pennsylvania, Philadelphia, Pennsylvania.—$1.50.*

FOLSOM AND YUMA ARTIFACTS, by J. D. Figgins, is a pamphlet (Vol. 14, No. 2 of the Proceedings of the Colorado Museum of Natural History) on Indian artifacts of flint which seem to indicate high skill among the Americans thousands of years B.C. *Colorado Museum of Natural History, Denver, Colorado.—Gratis.*

BULLETIN OF THE TEXAS ARCHEOLOGICAL AND PALEONTOLOGICAL SOCIETY, Volume 7, 1935. A paper-covered book containing 152 pages (of which 17 unnumbered pages are pictures) of articles on early Indian archeology in Texas, published annually by a widely known association of amateur archeologists. *Otto O. Watts, Secretary-Treasurer, Texas Archeological and Paleontological Society, 1925 Simmons Ave., Abilene, Texas.—$3.00.*

MAPS. A set of maps on a scale of four miles to the inch, showing all details of the existing transportation systems in Iowa, has been prepared by the Bureau of Public Roads of the Department of Agriculture in co-operation with the United States Geological Survey. The set consists of eight

sheets approximately 26 by 36 inches. *Superintendent of Documents, Washington, D. C.—$1.75 per set.*

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BUSINESS, INDUSTRY AND TAXATION is a reprint of an address by Lewis H. Brown, President, Johns-Manville Corporation, and reflects the attitude of a business man in high position toward the present status of industry and economics in the United States. *Write for Bulletin 236F to Scientific American, 24 West 40th Street, New York City. 3-cent stamp.*

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PATENTS AND INDUSTRY

(Continued from page 79)

fy a legal mind, so the argument goes, to pass upon an abstruse technical fact which may have taken a highly trained technical man years of intense study to learn.

Against this plan is the argument that it would set a bad precedent for employing technical advisors in all special branches of law. This would materially increase the cost of a suit to the litigants, if it is to be passed on to them, or to the taxpayers, if they are to carry the burden. Another point is that it would tend to set up a body of theoretical experts disassociated from practical industry so that their opinions might be impractical.

While Number 4 was not given by the Committee the status of a major recommendation, it is, nevertheless, of first significance. It is predicated upon the theory that there are now in existence many unexpired patents "which are now known to be worthless by those who hold them." The intent is to "remove from consideration all such patents which are regarded by their owners to be not worth payment of a tax." for patents upon which the tax remains unpaid would lapse. A hidden reason for this would seem to be a desire to penalize those holders of patents (notably corporations, as rumor has it) who wilfully withhold a newly patented product out of practice in order to prevent competition of the newer product with one already being produced that is perhaps inferior yet cheaper to make.

Several good results might come from adoption of Recommendation No. 4 for an annual tax on patents. Such taxes would reduce the annual cost to the inventor of securing a patent, for this annual tax would make possible a reduction in the present inordinately high filing and final fees. They would remove from the path of future industrial development the worthless and impractical inventions, which are both an obstruction and a nuisance, for the taxes on such patents would probably not be paid and they would accordingly lapse. The total revenue to the Government from patents could probably be increased through such annual taxes, while permitting the initial cost to the inventor to be reduced, for an inventor could easily afford to pay a reasonable patent tax starting at about the fifth year after issuance, if he were realizing an income from the patent.

On the other hand, who can determine worth? This argument and the one that "if the invention is truly important it soon attracts funds for its development" can both be demolished by one example. The Zipper type of fastener, around which has grown a large industry, was patented in the 90's but did not come into practice on an appreciable scale until five or six years ago! The lone inventor who has, in our history, contributed vastly to our progress, has often been impecunious and more often has encountered great difficulty in financing worthwhile patents only to see the fruits of his labors enjoyed by others after his patent expired. He would suffer under this tax. He might lose his patent entirely. The tax would thus appear to be discriminatory, for wealthy corporations would simply pay their patent taxes and refuse to be forced by them to place their patented products in production. Furthermore, any tax once instituted is seldom reduced but is usually increased from time to time. Considerable additional Federal revenue will have to be found in the future and Congress will naturally turn to the most easily tapped sources, such as annual taxes for patents. Should this happen, there is the danger that the taxes on patents will be raised so high that the entire patent system will be destroyed.

The Personnel of this Committee is as follows: V. Bush, Chairman, Vice President, and Dean of Engineering, Massachusetts Institute of Technology; W. H. Carrier, Chairman of the Board, Carrier Engineering Corporation; D. M. Compton, Industrial Consultant; Frank B. Jewett, Vice President, American Telephone and Telegraph Company, President, Bell Telephone Laboratories; H. A. Poillon, President, Research Corporation; Maurice Holland, Director, Division of Engineering and Industrial Research, National Research Council, Executive Secretary of the Committee.

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PROFESSOR Moulton is widely known as one of the two originators of the famous Chamberlin-Moulton planetesimal hypothesis, also as the author of standard textbooks on astronomy, celestial mechanics, and ballistics, and as an astronomer. Just as his widely used textbook of astronomy was written in unusually attractive language for a textbook, so is the present book still more readable. It is essentially a popular astronomy—neither a textbook with textbook earmarks on the one hand, nor a light-weight "easy" book on the other. It has solid substance all through. It starts with the earth and builds up, chapter by chapter, to exterior galaxies, in a grand crescendo. The author devotes some space to adverse criticism of the mystics among scientists, and is favorable to the rational interpretation of the universe. Heretofore we have usually recommended the same author's "Astronomy" (the textbook) to serious readers who wished to take up the science of astronomy anew, whenever they have inquired for the "best book to begin on." Now we shall recommend the newer work as still more suitable for the intelligent home student's first book. —$3.70 postpaid.—*A. G. I.*

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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COVER

IT may seem strange to see a white coated doctor using a hypodermic syringe on a sugar cane stalk. This, however, is exactly what J. P. Martin is doing in the photograph reproduced on our front cover. As told in the article on page 144 of this issue, scientists in Hawaii are striving to improve the resistance of sugar cane to certain diseases, and thus build up desirable qualities in the cane, which qualities may be perpetuated in future crops.

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50 Years Ago in . . .

Scientific American

(Condensed From Issues of March, 1886)

STEEL SHIPS—"As wood, in the construction of ships, was gradually replaced by iron, so iron, in its turn, is giving way to steel. The latter phase of the evolution has been very rapid. It is only seven years ago that steel began to attract attention as a substitute for iron in ship building. Its free use had just then been made possible—on the score of economy—by the perfection of the Bessemer process."

PATENTS—"According to the recently submitted report of the Commissioner, covering the business of the Patent Office for the last calendar year, it appears that there were 24,233 patents and reissues granted in 1885, as against 20,413 in 1884, and 22,383 in 1883. . . . The total expenditures on account of the office were $1,024,378.85, and the receipts were $1,188,089.15, or a surplus for the year of $163,710.30."

LIGHTING—"Numerous attempts have been made to obtain a successful incandescent electric light by means of secondary storage batteries, charged from dynamos, but, owing to the small amount of electricity obtained in comparison with the power required, these batteries have so far, we believe, not been proved to be a commercial success."

TYPEWRITERS—"Ten years ago, writing machines were little used, practically unknown to the great majority of writers, and were held by the few who knew something of them to be mechanical toys rather than the great time and labor savers they have since proved to be. Up to 1881, when the American Writing Machine Company, of Hartford, Conn., introduced the caligraph, double case writing machines were incomplete, being so constructed as to compel the operator to shift the carriage by a gratuitous stroke for capital letters and figures. The caligraph of which we herewith present an engraving prints each character in both (*sic*) capitals and small letters at a single finger stroke."

CARRIAGES—"Mr. Phelps, the new Minister to England, declared in a recent speech before one of the London guilds that 'America makes better carriages than England, and makes them cheaper.' The London correspondent of the Liverpool *Mercury* disputes this statement, and says that 'while America makes lighter and stronger conveyances than England, the landaus and broughams of New York are most of them built in England; and that, in spite of a heavy duty, carriages are bought in London and shipped to New York.'"

DATA—"Professor Huxley, in his presidential address before the Royal Society, said that 'of late years it has struck me with constantly increasing force, that those who have toiled for the advancement of science are in a fair way of being overwhelmed by the realization of their wishes. It has become impossible for any man to keep pace with the progress of the whole of any important branch of science.'"

ITALIAN RAILROADS—"The first line was built in that country in 1838, between Naples and Portici. In 1859 railways were opened in Parma and the Papal States. There are today approximately 15,000 kilometers of road built, under construction, or authorized, about two thirds of which are in operation. The engines are usually of English construction. Some of the more recent locomotives are from French, German, and Austrian establishments. Many of the gradients are very heavy, necessitating heavy engines."

STERN WHEELERS—"Stern wheelers have of late come very prominently before the public in consequence of the success which attended those built by Messrs. Yarrow & Co. for the Nile expedition. These boats were 100 ft. long by 18 ft. beam, drawing 18 in. water. One of them was put together above the second cataract near Wady Halfa, and was ultimately named the *Lotus*. This design of steamer having proved so great a success, Lord Wolseley desired the Government to immediately contract with Messrs. Yarrow & Co. for eight more, which were forthwith proceeded with, and one of these forms the subject of our illustration, which has been engraved from a photograph taken in Egypt."

TELEPHONES—"The growth of the telephone is one of the most remarkable in the history of inventions. In August, 1877, the instruments in use in this country was only 780, while in February 1885, there were 325,574. There are about 18,000 in Canada, and 13,000 in Great Britain. The number of exchanges has grown from 100 in 1880 to 782 in 1885. In January last there were 137,223 miles of telephone wire in this country. There are 5,186 persons furnished with employment by the exchanges. More different patents have been issued on the telephone than in any other single line of invention in this country. The total number for the ten years is 1,521."

FABRY'S COMET—"The students of Johns Hopkins University have been studying the path of the approaching comet, discovered by Fabry, and find that the celestial wanderer will reach its greatest brilliancy on May 2. At that time it will probably be a very conspicuous object in the western sky for some hours after sunset."

MERSEY TUNNEL—"Liverpool and Birkenhead occupy a somewhat similar position in respect to each other as New York and Brooklyn. On the 17th of January, 1884, little more than four years after the tunnel undertaking had been regularly taken in hand, the workmen on the Birkenhead side shook hands with those from Liverpool. So accurate had been the calculations of the engineers that the centers of the borings were less than an inch apart. The tunnel is now in full working order, and trains run freely through it."

TEMPERATURE—"The lowest recorded temperature, 393° below zero F., has been produced by Olszewski, by vaporizing liquid nitrogen under low pressure."

AND NOW FOR THE FUTURE

Possibilities of Commercial Transatlantic Air Service, by Reginald M. Cleveland.

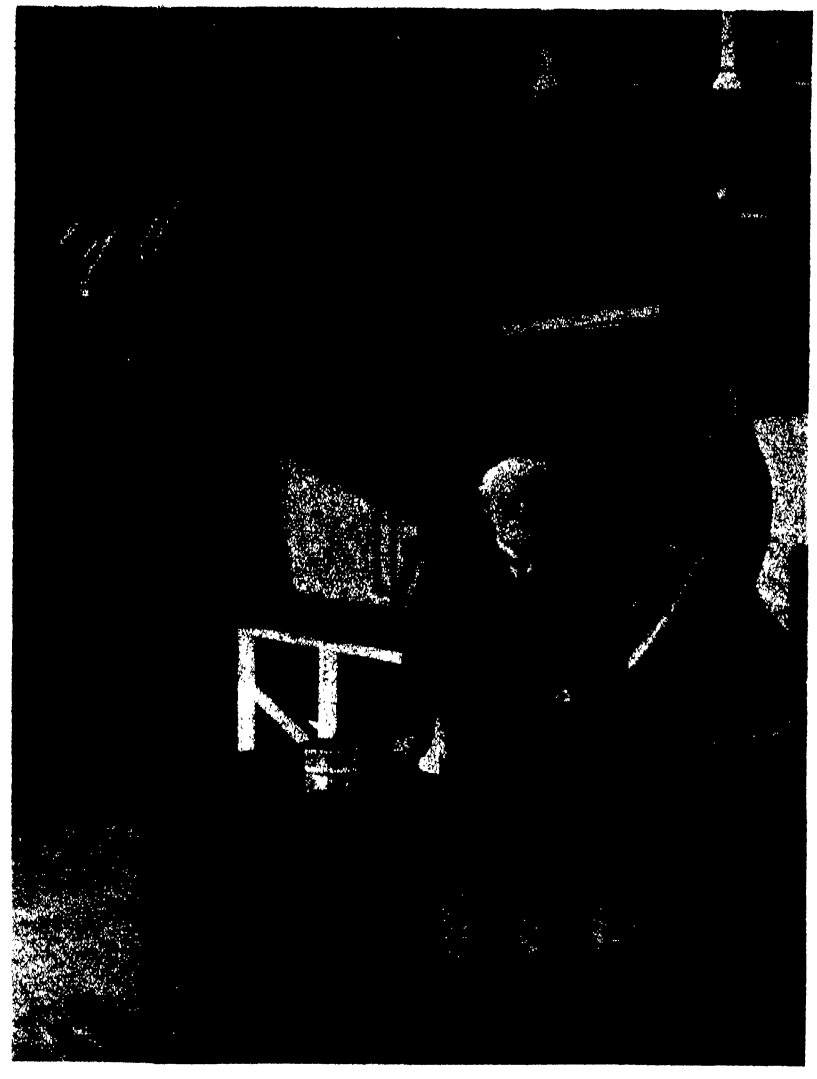
Salvaging Scraps—An Important Industry, by Philip H. Smith.

The Cabinet Maker's Art Applied to Bone Surgery, by Dr. Fred H. Albee.

Testing Uncle Sam's Metal Mules.

Trisecting the Angle—Why it is Impossible, by Churchill Eisenhart.

Personalities in Industry



AMBROSE SWASEY

AMBROSE SWASEY, the "Grand Old Man" of the mechanical engineering world, has just passed his eighty-ninth birthday and is still a captain of industry. He is the surviving member of the firm of Warner and Swasey, of Cleveland, manufacturers of two kinds of things that may seem widely different until it is realized that each is a precise, carefully made mechanism—machine tools (notably turret lathes) and astronomical instruments (notably large telescopes).

He has received many outstanding honors both from engineering and pure science: from the former, the famous John Fritz Medal and the presidency of the American Society of Mechanical Engineers; from the latter, prized memberships in the National Academy of Sciences and the American Philosophical Society, also honorary degrees from several universities.

In the photograph at the right, Mr. Swasey is shown standing in front of the massive polar axis member of the 82-inch telescope which has just been completed by his firm for the new McDonald Observatory in western Texas, which is to be run co-operatively by the Universities of Texas and Chicago and Yerkes Observatory. (Further details on pages 136 and 137.)

Ambrose Swasey was born and grew up in New Hampshire. He had little formal schooling and was a product of the "little red schoolhouse." He learned the machinist's trade and as he worked he met another machinist named Worcester Warner, a farmer's son. Warner had studied astronomy at home. These two formed a partnership and soon were foremen in the shops of Pratt and Whitney, at Hartford. Swasey quickly gained a reputation for accurate workmanship. The partners were saving their earnings, studying, and in ten years they were ready to start their own industry. It all reads like a story, or better—from plow boy to millionaire manufacturer.

They established an industry in Cleveland. Their first job was a turret lathe—then came twelve. They soon won a reputation for high-grade work. When James Lick gave 700,000 dollars for a 36-inch telescope the mounting job came to Warner and Swasey, because a telescope is both a big machine and a precise machine, and not every machinist could do that kind of work. Moreover, each was an amateur astronomer and understood at first hand the requirements of telescope users.

Later Mr. Swasey designed and then built a dividing engine capable of dividing circles for physical apparatus within a tolerance of a single second of arc —less than one millionth part of the circle. He and his old friend and partner built rugged mountings for other big telescopes: the 40-inch refractor at Yerkes, the 60-inch reflector in Argentina, the 72-inch reflector for Canada, and the 60-inch reflector for Ohio Wesleyan.

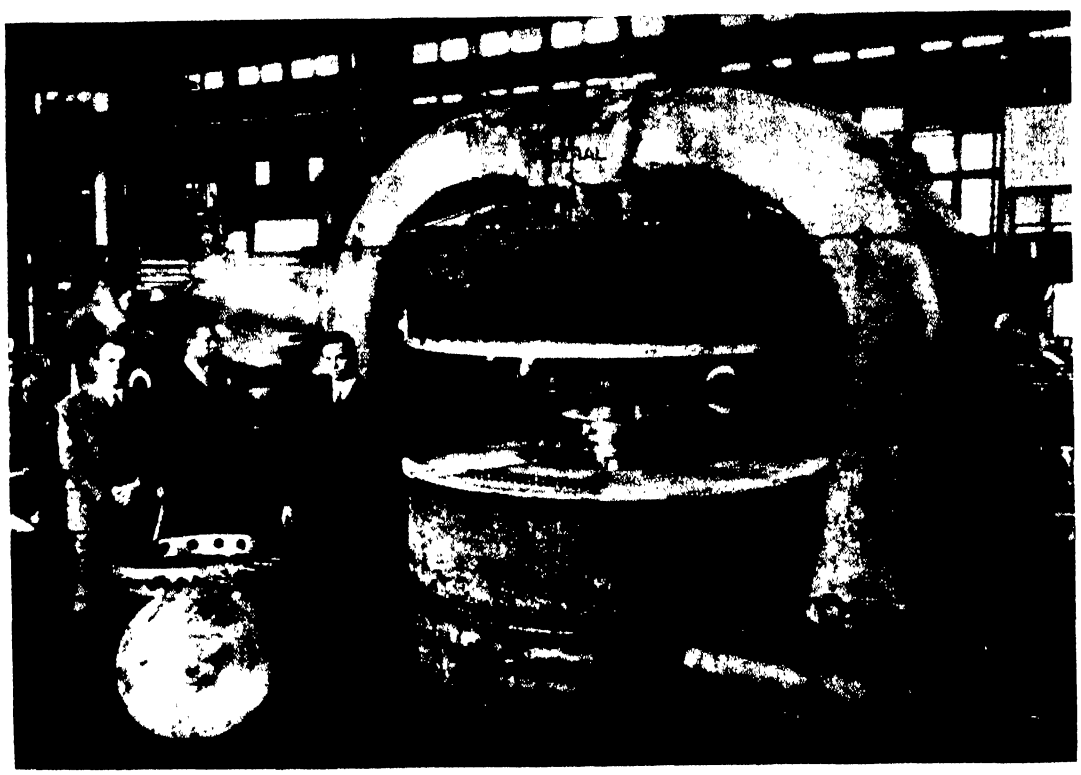
While they were acting as professional telescope builders they were also amateur astronomers. Making machine tools was their main vocation—making telescopes their avocation.

In 1914 Mr. Swasey conceived and founded the Engineering Foundation, for research in engineering, and endowed it permanently.

Mr. Swasey at 89 is strong and keen. When he was 80 he said, "I don't think the world is going to the dogs, as so many reformers would have us think. Young men and women of today are every bit as capable as their brothers and sisters of yesterday."

Calvin W. Rice, one of the founders of the General Electric Company, said of Mr. Swasey: "Whether it was a machine tool, the mounting of an optical instrument, a telescope, a range finder—all instruments of the greatest precision—everything he touched has reflected the perfection of human skill that is so typical of him. We have in him an example of the highest attainments in technical work, combined with an extraordinary capacity for co-operation." These two elements are not frequently combined in one man.

Dr. M. Stanley Livingston, physicist, and the 2,000,000 volt cyclotron (atom smasher) at Cornell University. This is the largest cyclotron now in operation east of the Rockies. It is being used for research both in physics and medicine (cancer); also in genetics, in the hope of producing gene mutations when neutrons are shot through the heredity cells



At Annapolis an old-fashioned electro-magnet of the kind long ago used in quenched arc wireless transmitters, which had been put away in moth balls, was found by physicists. Taken out, dusted off and shipped to Columbia University, it will be converted into a cyclotron like the one built by Prof. E. O. Lawrence (center) at the University of California

NEWEST MECHANISMS FOR SMASHING ATOMS

AFTER the young Prof. Ernest O. Lawrence invented the cyclotron type of atomic particle accelerator described in our January number by Prof. E. U. Condon, other physicists hastened to follow suit. To speed up the particles they are introduced into the strong magnetic field, which curves their path. Timed impulses delivered twice each revolution around the center speed them up by increments—like a dog running around a tree and being dug from behind twice in each revolution by a cat.

Rats taking an interest in a chemical having a vitamin content—"babies cry for it"

VITAMINS TODAY

Thus Far We Have Vitamins A,B,C,D,E,F,G,H,K, and Sometimes We Think There are More... Some May be Imaginary ... But Forget Vitamin Worries

By T. SWANN HARDING

A NUMBER of years ago a traveler, just returned from Central Africa, told how he had made a fast friend of an ape there by feeding the animal hard-boiled eggs. It puzzled him, however, to see that the ape not only removed the shell from the egg, an article of food with which he was almost certainly unacquainted, but threw away the white as well and ate only the yolk. The puzzle was solved only when the traveler returned to the civilized world, for then he discovered that vitamins existed. They had been found during his absence. Furthermore the yolk of the egg contained whatever vitamins there were in eggs. Apparently the ape knew intuitively what it took nutrition scientists many years of painful study to find out!

Perhaps this story is somewhat exaggerated. It is certain, however, that laboratory rats will deliberately choose to eat little dry pellets which contain the vitamins necessary to them, if similar tablets containing no vitamins are also accessible. But this is not attributed either to instinct or to intuitive knowledge. It is assumed that when the animals feel poorly they seek to round out their diet by eating those things which make them feel better.

These days, when the necessity for absorbing our vitamins is continually preached at us, many skeptics are naturally inclined to ask: What on earth did our ancestors do when there were no vitamins? Did the world have to wait for modern nutrition scientists to tell it what to eat?

EXPERIENCE seemed to teach both animals and primitive human beings how to get a fairly well-rounded diet in their own natural environment. Not only did the American Indians faithfully eat stews of hackberries and other foods of high calcium content, but they, like other meat-eating savages, were said always to consume the internal organs of animals slain, and there vitamins are concentrated.

Just as the diseases scurvy and rickets early turned attention to vitamins C and D, so beriberi aroused the suspicion that it was caused by dietary deficiency. Between 1897 and 1906 Eijkman was showing that a diet of polished rice produces a disease in fowls that closely resembles human beriberi. This disease he held due to lack of an unknown substance necessary to normal health and growth, a dietary supplement that existed in rice polishings, the outer layers and embryo of rice kernels.

In short, work in many laboratories, especially in Great Britain and the United States, began to show that fats, proteins, carbohydrates, water, and a few mineral salts would not make a complete diet. A mysterious something else was needed. Later it became clear that quite a group of mysterious something elses had to be eaten by animals if they were to grow normally and maintain good health. These mysteries came to be called "vitamins."

Until just a few years ago the vitamins remained elusive. No one knew what they were. Many doubted their existence altogether. Others imagined they were living entities, perhaps crawling about like tiny bugs or worms, or existing as micro-organisms. Today at least

This rat was purposely deprived of vitamin A. His fur is rough, he is underweight, and his eyes have ulcerated

four of the vitamins are available in crystalline form and their chemical composition is known. Only recently crystals of a fifth were displayed.

Since the chemical composition of the vitamins remained unknown long after nutrition scientists were reasonably sure they existed, they began to letter instead of name them. They had different effects and must somehow be classified. Lettering them A, B, C, and so on, offered the best way out, as it committed the relatively ignorant scientists least in those earlier days of vitamin work.

Between 1906 and 1913 it began to be very apparent that rats would neither grow properly nor maintain health if fed what was regarded as a complete, though a purified and synthetic diet. Something else was needed. That something else could be extracted from egg yolk. It also occurred in cod-liver oil. When this so-called "growth-promoting" substance was added to their diet the rats became vigorous and healthy.

HERE was the first vitamin to get a letter. It became A, and today it has enough colleagues to make a football team, and there may even be two or three substitutes—provided they all exist, though maybe some of them do not! For vitamins have strange habits. They tend to appear and then disappear. One vitamin tends to split into several fractions, each setting up on its own, and then some of these fractions may later prove to be more or less chimerical.

The approved functions of the vitamins also change. It is no longer proper to speak of vitamin A as "growth-promoting," for poor growth will occur in the absence of almost any of the vitamins. Nor has the word "growth" been defined clearly. It is quite possible for an animal to grow, by increase in length, even while it loses weight. This is just what a child does when seriously ill.

But vitamin A also helps to keep our mucous membranes in good shape and to aid animals in the reproduction of their kind. However, it would be safer to say that this is true of rats. Human beings do, however, suffer from an inflammation of the eyes, called ophthalmia, when too long on a vitamin-A-deficient diet. Vitamin A also appears to occur in the eyeballs, its absence there producing a type of night blindness.

Rats, deprived of vitamin A, easily become infected because their mucous membranes are injured; also they can not reproduce. But there is not sufficient information to justify any reference to

A laboratory rat being weighed in. Each animal's weight is recorded

vitamin A as the "anti-infective," in so far as human beings are concerned.

The best work published to date indicates that feeding up on vitamin A does not reduce the number of colds or respiratory infections the individual has. Not even the addition of both vitamins A and D to a generally deficient diet will improve the growth of children or their resistance to infection. This need not be taken as final. The question is not entirely settled. More work should be done, but what we know so far points in the direction indicated.

What is vitamin A? It appears that whenever the composition of a vitamin is determined it turns out to be some complex organic chemical compound or other. There are at least four such substances capable of producing the effects attributed to vitamin A. These are alpha, beta, and gamma carotene (the yellow substance in carrots), and cryptoxanthin. Weight for weight, beta is the strongest of the carotenes in vitamin A effects—the ones which are cited above.

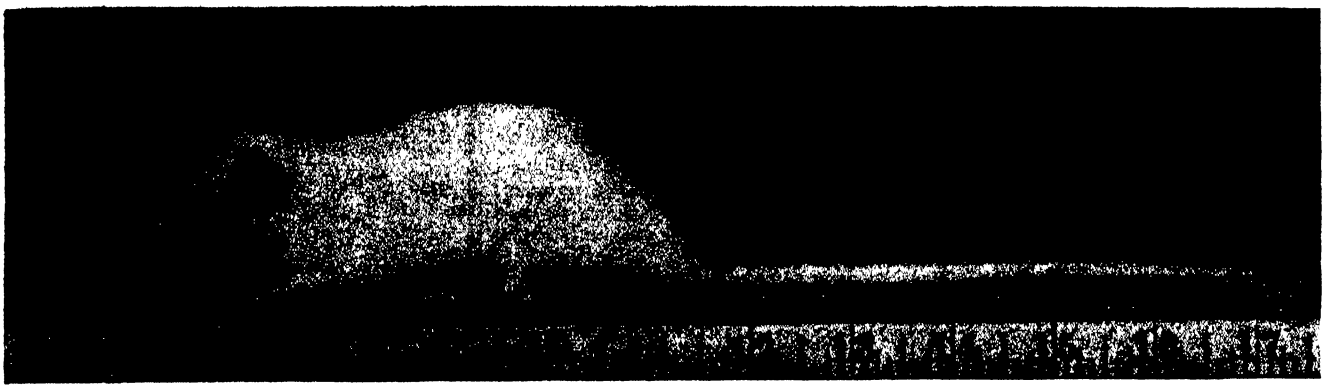
Are these chemicals, any one of them, vitamin A? Strictly speaking, the answer is no. But any of the four will undergo changes in the animal body and become vitamin A, which is said to have the chemical formula $C_{20}H_{30}O$—that is, 20 atoms of carbon, 30 of hydrogen, and just one of oxygen. The true vitamin A itself occurs in cod-liver and halibut-liver oil, as well as in other fish oils. It has been prepared in a state of high purity.

Preparations of vitamin A look like a thick, yellowish oil. The vitamin can be taken directly, although the administration of any of the four chemical compounds mentioned above will produce the same effect. The unit of vitamin A is 0.6 microgram of beta carotene, and a microgram, being a millionth part of a gram, which is itself a thirtieth part of an ounce, is an exceedingly small unit of weight.

WHEN we come to vitamin B we find a welter of confusion. For one thing, Europeans call it B_1. For another, it has been split five or six ways since Eijkman said it prevented beriberi. Soon after that it was found to be a complex and B_2, later P-P, later G, appeared, which prevented the disease of pellagra. Some even claim that there are as many as nine different independent fractions today of the old vitamin B.

The main fraction, still called vitamin B in America, still prevents beriberi, but it is also necessary to maintain an animal's growth. Such formulas as the following have been proposed for it: $C_{12}H_{17}N_4OS$, or $C_{12}H_{17}O_2N_4S$, so it contains nitrogen and sulfur, in addition to carbon, hydrogen, and oxygen. It is made by extracting rice polishings with water and absorbing the vitamin itself on fuller's earth, and is now available in pure form.

All the fractions of the old vitamin B are soluble in water and occur in yeast, hence some lump them as the Y vitamins. Some of the fractions are more easily destroyed by heat than others, which aids in telling them apart. The lack of one fraction causes a peculiar type of paralysis in young chickens.



Unlike the rat shown opposite (his own brother) this rat received a normal diet, hence enough vitamin A

Lack of another fraction injures the health of pigeons, and so on. Until much further investigation has been carried on no accurate exposition of vitamin B complex can be given.

Vitamin C is now available at a fairly low price, in the form of a white crystalline powder that looks like powdered sugar. It turns out to be an acid known to the more esoteric chemists as l-ascorbic and having the formula $C_6H_8O_6$. The acid is altogether new and the name is designed to abbreviate the word "anti-scorbutic," or scurvy-preventive.

VITAMIN C, as is perhaps too well known, occurs in the citrus fruits and in tomatoes. The vitamin is quite stable when kept at the normal acidity of lemon juice. It is also known to prevent certain changes in the gums which tend to appear in scurvy, and to help keep the dentine of the teeth in good condition. The unit of vitamin C is 0.05 milligram (not microgram, as before) of l-ascorbic acid—the milligram being a thousandth part, instead of a millionth part, of the thirtieth of an ounce.

Among the symptoms caused by lack of vitamin C are the bleeding gums and membranes characteristic of scurvy, as well as decrease in weight and failure to grow properly—associated, for that matter, with every vitamin lack. The disease diphtheria also causes bleeding from certain membranes, and a curious recent finding indicates that dosages of vitamin C fortify animals against diphtheria toxins.

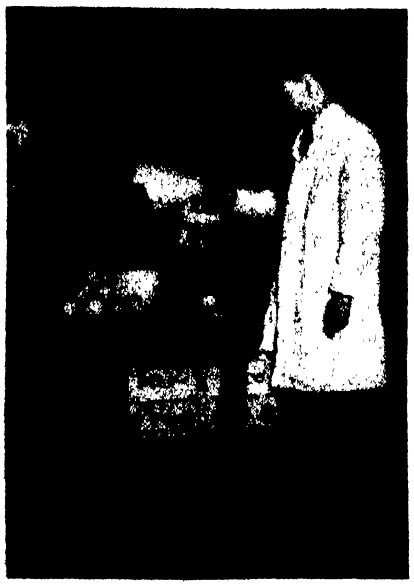
Guinea-pigs deprived of vitamin C readily contract diphtheria. But guinea-pigs which have a minimum supply of this vitamin, even though it is just sufficient to prevent the development of scurvy and no more, are very resistant to the disease. In other words, vitamin C also seems to have an anti-infective function. It aids in building up immunity.

Vitamin D, which occurs in the oils of the cod, halibut, salmon, sardine, and other fish, is definitely known to prevent rickets. This fact was found out and forgotten several times before we decided to admit it permanently. Possibly vitamin D has other functions, but that is in dispute. To date, nothing can be claimed for it scientifically, other than it is an antirachitic agent.

The chemical formula of vitamin D is known and it is produced artificially by exposing the white crystals of ergosterol to ultra-violet rays of a mercury lamp or in sunshine. The artificially produced vitamin is called "calciferol" and the unit is the biological effect of 0.025 microgram of that substance. It is more stable than vitamin A, though not entirely stable.

The lack of vitamin D first produces certain changes in the structure of the teeth, just as vitamin-C lack does, these changes heralding rickets in one case and scurvy in the other. But the addition of vitamin D to an otherwise deficient diet will not by itself produce sound teeth and normal growth. The diet has to be rounded out as a whole. Vitamin D also occurs in egg yolk, so the African ape was right!

There has been some alarm recently about the poisonous nature of cod-liver oil, or the possibility of dangerous overdosage with vitamin D. So far there is comparatively little scientific justification for such alarm. Such massive doses of vitamin D would have to be taken to cause poisoning that there is little danger. Experts estimate that it may take at least 1000 times the normal dose to cause trouble.



H. H. Mottern, food chemist, of the U. S. Department of Agriculture

The formula of vitamin D, or calciferol, is $C_{28}H_{43}OH$. For a time it was held that vitamin D of cod-liver oil had a different effect on infants from that produced artificially from ergosterol, but recent work indicates that this was a mistake. However, while vitamin D prepared from the oils of the halibut, cod, and tuna also acts quite the same when tested on rats, the tuna-oil vitamin D is not so effective as the others in promoting proper bone formation in chickens.

Leaving vitamin D with the hope that it will not break up into too many pieces, we proceed to vitamin E, the so-called sex or antisterility vitamin. Dr. Herbert M. Evans found that when rats were fed a diet complete in all known nutritive and vitamin factors, they failed properly to reproduce. The sex glands of the male rats permanently degenerated. The female rats became pregnant but could not produce their young because the embryos reabsorbed and disappeared. However, it is to be remembered that lack of vitamins A or B can also cause difficulty in reproduction.

SO many and such diverse claims have been made for this vitamin that many scientists wonder whether it even exists. Some declare that it cures sterility, others that it promotes reproduction, rejuvenates the sex organs, determines the sex of offspring, remedies anemia, or even that it prevents cancer. The only scientific claims that can be made for it are very limited. It is said to occur abundantly in wheat-germ oil. In the fall of 1935 its discoverer, Dr. Evans, displayed it in the form of a white, crystalline powder looking like sugar or salt, yet there are other nutrition workers who dispute its very existence. Not even Dr. Evans, however—or least of all he—claims that vitamin E is the sex-potency factor for human beings.

The subject of vitamin E needs complete re-investigation. It is probable that this may be undertaken in the near future. Meanwhile there is little or no

IN the accompanying article Mr. Harding urges that "the ordinary well-balanced diet supplies all the vitamins that human beings usually need," a statement which is concurred in by the Editor. In a way, it is regretful that the findings of science are so readily available to those who may have applied them too enthusiastically in one direction—to bolster "scientific" food fads. Few if any of the scientists who have done the most important research on foods—research which is highly valuable to *medicine*—are in sympathy with the tendency to overemphasize consciousness of their vitamin content. The verses quoted below—their authorship regretfully unknown—reflect the feeling of the staff of this magazine with regard to food fads.

—*The Editor.*

Methusaleh ate what he found on his plate,
And never, as people do now,
Did he note the amount of the calorie count—
He ate it because it was chow.

He wasn't disturbed, as at dinner he sat,
Destroying a roast or a pie,
To think it was lacking in granular fat
Or a couple of vitamins shy.

He cheerfully chewed every species of food,
Untroubled by worries or fears
Lest his health might be hurt by some fancy dessert—
And he lived over nine hundred years!

danger that human beings ever lack this vitamin sufficiently to cause what has merrily been called "alimentary castration."

Turning to vitamin F we approach a now-you-see-it, now-you-don't phenomenon. The letter was once used to designate an unknown that seemed necessary to make animals grow when all the other vitamins were present and it alone was missing. Later investigation appeared to prove that this unknown was a fatty acid called linoleic, but the use of the letter F to designate the substance was discontinued.

VITAMIN G, as we found above, is that part of the old vitamin B that prevents pellagra. Europeans tend to call it B_2. It occurs in yeast and in 1932 was reported to have been split into an X and a Y factor. These were said to differ slightly in their effects upon rat growth. Sometimes the vitamin is called more simply P-P or pellagra-preventive. Today it is claimed that other substances besides vitamin G are needed to prevent pellagra, but we need not go into that.

The letter H is still claimed by the discoverer of vitamin H which, it is said, must be fed to trout to make them grow properly. Human beings need not be concerned about it. Neither need they worry about the letters I and J, which have not yet been used to designate vitamins. For some reason the latest vitamin discoverers to report jumped to the letter K.

This vitamin K is said by certain Danish workers to prevent a variety of internal bleeding from which chickens suffer if deprived of it. Vitamin K occurs, it is said, in hemp seed, kale, tomatoes, and hog liver. In some of its properties it also resembles vitamin E. No claims can yet be made as to its effect, if there is any, on human beings.

Finally, there is the vitamin-like substance which is said to play such an important rôle in liver functioning that its absence can cause a form of diabetes. It is called choline and has not been given a letter. It occurs in yeast, egg yolk, and meat, and its lack causes a fatty degeneration of the liver. It also needs further study.

The very common question—"Well, so what?"—inevitably arises at just this point. As usual, it is somewhat difficult to answer. First of all, vitamins were scientific concepts. They were so elusive that many thought them imaginary. One by one, unknown somethings were discovered which appeared to promote growth, to prevent beriberi, scurvy, rickets, or pellagra, or to make reproduction possible. Simplicity gave way to complexity.

In time the original vitamin A had split into five fractions; there were perhaps as many as nine fractions of the old B, at least four of the old D, and possibly two of vitamin G. Sometimes several entirely different chemical substances would produce the effects attributed to a single vitamin; as, for example, the four chemicals that produce vitamin-A effects. Then the vitamins began to be purified; they appeared in crystalline form, and their chemical composition was in some cases determined.

Here true science begins, for we can take these definitely known chemical compounds and test their physiological effects on animals and on men. Until such carefully controlled research has been carried much further than it has today we should go slowly in dosing ourselves with vitamins, which are really more nearly drugs than foods. They compare rather with hormone substances than with ordinary foods, very minute quantities producing powerful results.

It is true that the development of ophthalmia, a certain eye disease, means lack of vitamin A; the development of beriberi indicates that vitamin B is lacking, of scurvy that C is lacking, of rickets that D is lacking, and of pellagra perhaps that G is lacking. In these cases a specific vitamin need is indicated and the appropriate vitamin should be given as a remedy or medicine.

In general, however, a well-rounded diet and exposure to sunshine are more important than vitamin concentrates in promoting health. This means that there must be sufficient meat, eggs, milk, fruits, and green vegetables on the menu. If the ordinary food elements, including minerals, are not abundant in the diet, no amount of dosing with specific vitamin concentrates can be expected alone to atone for this deficiency.

THERE is a great tendency today to add vitamins to foods. The impregnation of many foods with vitamin D is an example. Such addition at once makes the food over into a drug. But the wisdom of this is doubtful, for the ordinary well-balanced diet supplies all the vitamins that human beings usually need. Vitamin D may be prescribed, of course, if rickets appears, but other than that we should go slowly.

Most of the vitamin work has been done on animals; carefully controlled work on human beings remains to be carried out. We as yet know too little of the vitamin D requirements of older children and adults, of the extent to which the body stores the vitamin, or the amount ordinarily provided by sunshine. Scientists know much less than the average layman evidently imagines about vitamin D. Pregnant and lactating women and young children need it in abundance, but it is plentiful in many fish and relatively so in eggs—foods which most of us eat in an ordinary everyday diet.

The American Medical Association not long ago denounced the crude and unscientific character of vitamin therapy. It said there was no more reason for people to take varied dosages of several vitamin concentrates incorporated in food or drug products than for them to dose up on any other individual, unrelated dietetic components. There is no more reason for a vitamin debauch than for a phosphorus or a sugar debauch. Nor is there any evidence to show that the vitamins increase one another's beneficial effects, while there is some to indicate the reverse.

In brief the best answer that can be given to the question, "Well, so what?", is probably: "So try to eat a varied and well-rounded diet and expose yourself to sunshine now and then, and forget your vitamin worries."

OUR POINT OF VIEW

The Living Wilderness

THANKS to the unremitting efforts of a determined band of conservationists and nature lovers who fought tooth and nail for many years, we have today the great National Forests, preserved for all time against serious encroachment by selfish interests. There remain about four-fifths of the nation's wilderness areas in state and private hands, and here protection is more difficult; probably it is only a matter of time before much of the latter area will have disappeared under the manifold pressures of civilization and its various interests.

A new movement is now afoot and likely to gain velocity, whose aim is to save in wholly pristine form, before it is too late, some real samples of America's primeval wilderness—to save these samples not merely uncontaminated by hot dog stands, dance halls, and similar spoor of humanity in the large, but free even from motor highways, truck trails, rest houses and, in short, everything except what man found on this continent when he first came to it. Such areas would be wilderness in fact, and the "Wilderness Society," with its headquarters at Washington, is the new organization which is attempting to arouse public interest in the preservation of samples of Nature in our land.

No motor roads. No graded trails. No "official" rest houses or camps. No forester's trails and no foresters. No caretakers. Nothing but the wilderness.

Hard to get at? Yes, purposely hard to get at; forcing a man who wishes to enjoy a quiet fortnight or two in the wilderness to put a pack basket on his back and make his way into the preserve under his own power.

Self-defeating because unavailable to everybody who owns a car? Exactly. There are now plenty of places where car owners may enjoy nature without the effort of going on Shanks' mare to see them. Just the consciousness that, over the hill, a motor trail penetrates the wilderness spoils such a place for the true wilderness lover; it no longer remains a wilderness.

No doubt this conception, fostered largely by Robert Sterling Yard, secretary of the "Wilderness Society," will cause many a dyed-in-the-wool "developer" to knit his brows. Not to change or "improve" anything in the wild, wild woods? Not to add a network of motor roads; or anyway, if denied that, at least to whitewash a few rows of stones? Your developer will hardly grasp it.

Others, who sense the feeling of freedom afforded by the full breathing space of half a hundred miles of nothing but the unspoiled wild in every direction—room in which to breathe and let the soul expand—will understand it without further explanation.

Here and there, disorganized but hoping, there are probably millions who would like to know that there remained a few unspoiled pieces of the wilderness in the midst of our civilization, which no civilized instrument could penetrate or despoil or contaminate, even if they never hoped to set foot in it themselves. Now comes a chance for these people to get together and make their influence felt in favor of "the living wilderness."

"Water, Water, Everywhere . . ."

GOLD from sea water; a thought to conjure with, an aim of scientists and pseudo-scientists for decades, a bubble for wily stock promoters, and a snare for investors! There is gold in sea water to the value of untold billions of dollars, and the problem of capturing some of it in commercial quantities—possible, doubtless, at some future date—has so intrigued the imagination of the world that the recovery of a more vital substance from sea water has had but scant attention except in special quarters. This is water—plain, life-giving, fresh water!

To the average person, the salt of the oceans is the familiar salt of the dinner table. To the chemist, however, it is a combination of a vast number of salts of many elements. To remove these and leave potable, or at least industrially usable, water, is the great problem. Arid regions near coasts might be made to bloom were this problem solved so that fresh water could be obtained cheaply from sea water. Steamships, using vast quantities of fresh water for their boilers, and now depending on an extremely expensive distillation process, would benefit; steam plants ashore near the sea, also using billions of gallons of water for boilers, might be divorced from city water supplies, thus solving the problem of adequate water for human consumption; there might even be a possibility of solving for all time the drinking water problems of such cities as New York which, already, is taking water from hundreds of miles away.

A dream? Not at all. Some progress has already been made, according to *Science Service* which reports success of a new process developed in the British government's experimental laboratories at Teddington. So far, little actual information on this achievement is available, though it is said that the processed water is fit to drink but not particularly palatable. It is said to be, however, suitable for use in steam boilers and for other industrial purposes.

In this, the aim of science should be to get fresh water comparable with that of a city's present mountain stream supply. In our opinion, the successful achievement of that end would benefit many millions of people. The problem, therefore, ought to be a major one for science.

Television's Status

THE progress of television in the past few years has been most unsatisfactory, from the standpoint of the general public. Developments are announced in the press, predictions are made, and then a great wall of silence grows up. Probably the most encouraging news of the past year was the announcement by RCA that they would spend a million dollars in developing transmitting and receiving equipment and making field tests that presumably should point the way to commercial operation. But again the wall of silence. True enough, the RCA announcement stated that the work would take from 12 to 15 months before any results could be hoped for, and the only thing to do is to wait.

Now comes another ray of hope. Television has been under the sympathetic eye of the Federal Communications Commission, and in a recent report to Congress the Commission stated that television is practically ready for public use. But—and this is a big "but"—the Commission went on to state that the various experimenting companies have been working on so many different types of transmission systems that to receive even the experimental transmissions requires a different receiver for each.

What is the answer? The Commission states: "In order to give television service, it is necessary for the different manufacturing companies to standardize their transmissions and produce receivers that can receive all programs transmitted."

Perhaps there is a link between RCA's announcement and the statement by the Commission. Perhaps the work of the RCA may point the way to that desired standardization. Certainly, it is a step in the right direction.

DEATH ON FOUR WHEELS

Element of Chance Must be Minimized . . State Accident Survey Shows the Way . . . Cultivate the Proper Attitude Toward Other Drivers

By JOHN HENSHAW CRIDER

A RED light flickered on the panel of the troopers' switchboard: a buzzing sound impatiently demanded attention.

"There's a car turned over and rammed against a tree. You'd better hurry!" cried the voice on the wire.

"We'll be there in a minute." The desk sergeant called the trooper on reserve.

"Another bad one down on the West Hill curve. Get going!"

The trooper found what was left of a roadster jammed like an accordion against the stalwart trunk of an oak tree. The car had turned over in mid-air, landing with full weight, plus momentum, against the immovable impediment.

"We can't get 'er out. Wedged in too tight," said a bystander.

IT took an hour to get her out—what remained of her. She was an 18-year-old girl on her way to college. Her car was an expensive make—advertised as capable of 100 miles per hour, with flawless brakes, and strong steel body. But there was no guarantee against taking chances on the road!

As far as the trooper could learn from witnesses, the girl had tried to pass a car approaching a curve. As she got out on the left of the two-lane highway another car appeared in her path, speeding around the bend. She did the one thing that minimized the consequences of that accident. She turned off the road to the left, killing herself. If she had kept straight ahead there would have been a certain head-on collision, possibly involving the car which she had passed. If she had tried to cut over to the right she would surely have involved the passed car and probably the oncoming one too. Her's was a generous gesture, but it cost her life.

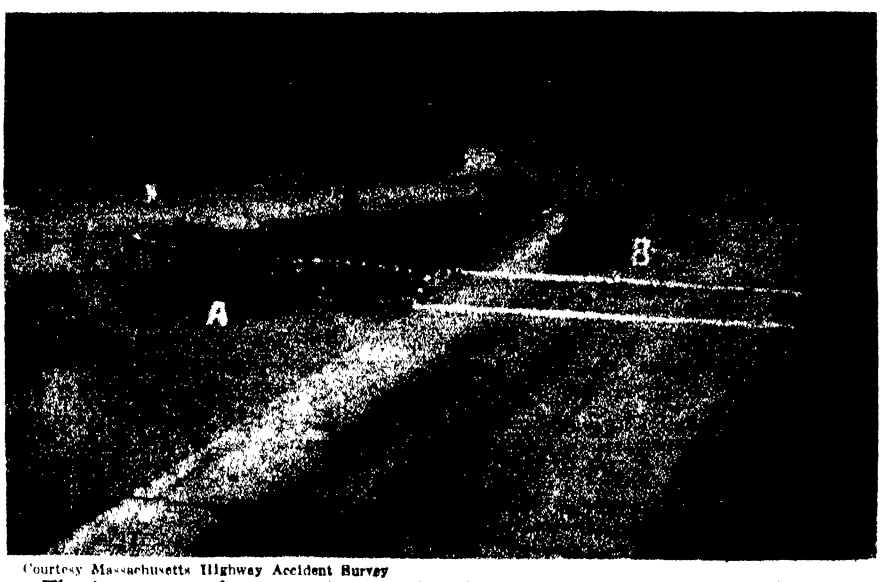
There were about 36,000 deaths in the United States last year attributed to the motor car. More than 50 of these came to the personal attention of the author, and it was his experience in talking with relatives of the deceased that *chance* was the factor usually blamed. They could hold nothing against the members of their families who had been killed. They really seemed to believe "it was just *chance*."

THE editors make no apologies for the expressions of personal opinion by the writer of the accompanying article. These statements coincide with the opinions of the editorial staff on the subject of motor-car safety, and should be read and taken to heart by everyone. In a letter to the editor, Mr. Crider wrote: "I am intensely interested in this great problem of making the highways safer. I have seen too many bloody bodies dragged from crushed cars." If only more car drivers could say the same. . . .

As long as chance is permitted to have a leading place in the list of accident causes, this country is not going to be relieved of its present appalling auto death toll. If we are to minimize the element of chance, we must study automobiles and the habits of those who drive them. Whenever humanity has been faced with a serious hazard, studies have been made to conquer or reduce the danger. It was so with yellow fever, diabetes, diphtheria, and railroad accidents. Eventually, when the public has been sufficiently impressed with some prevalent danger, the big guns of science have been trained on it. So it must be with the auto death plague.

An excellent first step in the right direction has been made by the Commonwealth of Massachusetts with the co-operation of the Federal Government and the Massachusetts Institute of Technology. For months the modern facilities of the Massachusetts Institute of Technology were directed to the problem of explaining why there were so many accidents, why so many killed. How did these drivers operate who did so much damage? What did they think of suggested methods for lessening the toll? How much of the blame could be placed on motor-car construction, and of what importance was the factor of driver-ability to avoid accidents?

THE Federal Government contributed more than 400,000 dollars to the project. The best brains of Massachusetts turned their abilities toward the solution of the problem. Director Robert C. Eddy sent cruising cars throughout the Commonwealth to study the tactics of drivers. Scouts were posted at the scenes of most frequent accidents. Observance of traffic laws was studied in various communities. Some 200 re-



Courtesy Massachusetts Highway Accident Survey

The instruments for measuring speed and driver reaction time are in the car parked at A. The car B is about to pass over the trip cables in the road

When a motor vehicle tries to beat a train to a crossing . . .

ports giving the results of local accident surveys were sent to as many municipalities, thus assisting them in reducing their accident toll. In all, more than 2,500,000 cars were studied on the road.

Now this is the kind of thing that is going to reduce drastically the chance element in motoring, if only drivers, public safety authorities, and manufacturers will make the most of the information made available. The same thing should be done in every state in the Union. The results should be dramatically publicized. There are ways to cut the fatalities, if people will only find and use them.

THE Massachusetts Highway Accident Survey showed that the percentage of drivers who flagrantly violate the law varied extremely depending upon the law involved. The percentage of violations of traffic laws varied from 0.2 percent of drivers who failed to keep to the right when a car was passing, to 14.9 percent who failed to keep to the right through underpasses with no traffic near, and 98.5 percent who made turns from the correct lane (affecting traffic to the right) without using the proper hand signal. The total of right turns observed in which drivers failed to give hand signals (and which affected other traffic) was 99 percent. Only 8.4 percent of the cars failed to operate properly at intersections controlled by traffic lights. It was estimated, however, that on the basis of these figures the total number of traffic-light violations per year would be 23,500,425.

The average speed on straightaways was found to be 36.6 miles per hour. On short-radius curves traffic slowed down to an average of 27 miles per hour. Considering the fact that these speed studies were made during the winter months when snow was on the ground, it does not appear that the Massachusetts driver is by any means a slow-poke. Strangely enough, the average speed of drivers was faster at night than in the day. Maximum speeds varied from 75 miles per hour in the daytime to 81 in the evening.

As to vehicle lighting, the Survey found that out of 101,391 cars inspected, a total of 8.31 percent had defective lights. Among these were 2.24 percent with one head light out, and 5.36 with no tail lights.

By far the majority of accidents occurred at dusk, from 4 to 8:30 P.M., depending upon the season. Few drivers seem to appreciate that visibility is extremely poor in the twilight period after the sun sinks low on the horizon. Most drivers never show their lights until complete darkness descends. How many of them realize that their chances of accident are much greater in those last daylight minutes than after night has fallen?

To determine the attitude of motorists on questions important to law-enforcement agencies, the Survey sent out questionnaires to a large cross-section of the driving public, and received 12,127 replies. Here are some of the questions and answers, from which you can draw your own conclusions:

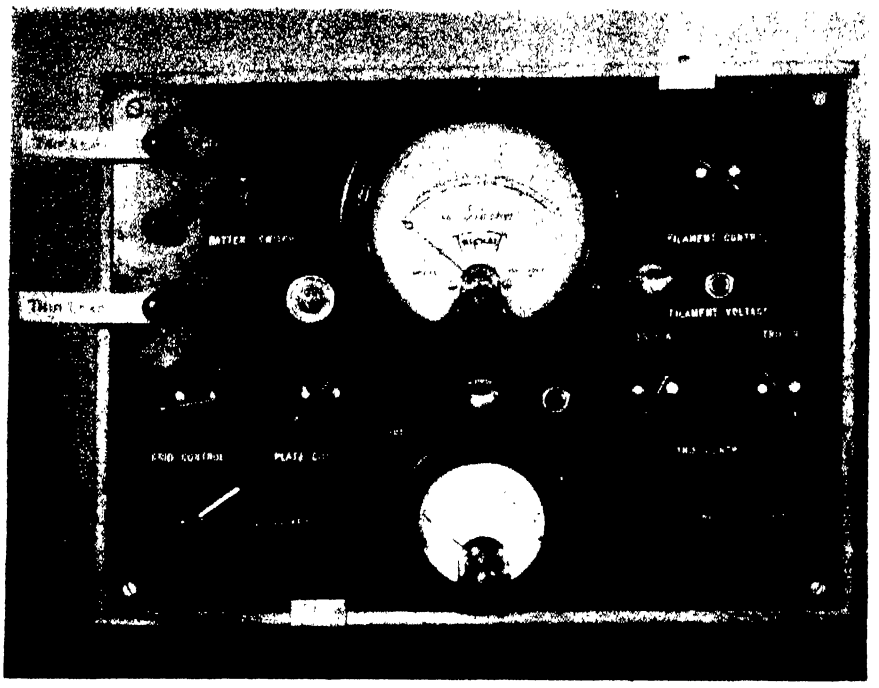
	Percent *Yes*	*No*
Do you believe it advisable to re-examine operators at stated intervals?	51	49
Do you believe that a reduction in insurance premiums for good drivers and an increase in premiums for careless drivers would help to prevent accidents?	86	14
Should schools be required to teach accident prevention?	97	3
In general are automatic lights and flashing beacons properly located?	89	11
Do signs similar to those used in Rhode Island showing permissible speeds on the highway help to prevent accidents?	74	26

SCIENCE has not only charted and interpreted phenomena, but through its knowledge and ingenuity it has contrived instruments with which to record some of the more delicate measurements such as reaction time of drivers, and the proper headway of cars traveling in lines. In connection with the Massachusetts Highway Accident Survey, Dr. V. Bush of M. I. T. developed a timing apparatus which was used for the aforementioned purposes.

The device consisted of a condenser charged by a dry battery. For time measurement purposes the condenser was discharged through a fixed resistance, and the voltage remaining across the condenser at the end of the time interval was determined by connecting it to the grid circuit of a three-electrode vacuum tube and measuring the plate current. The ratio between the initial and final condenser voltages bore a known relationship to the interval of time.

By means of this apparatus the Survey measured the braking-reaction time of drivers under actual road conditions. Many previous studies of this kind had been made elsewhere, but, so far as was known to the Survey, only under laboratory conditions. The Massachusetts test was made on 180 individuals, representing characteristic types of drivers. The time taken most frequently for drivers to react to the necessity for applying brakes was found to be 0.52 seconds, and the average time elapsed was 0.64 seconds. Five percent of those observed were found to require more than one second to react.

The importance of the consideration of braking-reaction time is realized when one considers that a car traveling



Close-up of the time interval measuring device used for a motor car survey in Massachusetts. The upper meter dial is calibrated directly in miles per hour

40 miles per hour is going nearly 60 feet a second. Thus, a driver whose reaction time is one second cannot safely drive at this speed closer than 60 feet from the car ahead.

The Survey determined that poor highway lighting is worse than no lighting at all, and that a driver with a braking-reaction time of one second might drive 40 to 45 miles per hour at night without much danger of striking pedestrians, providing his brakes are good, his lights correct, and if he slows down in the presence of glaring headlights. It found also that while there is a small percentage of drivers who seem to be chronically prone to accidents, it is difficult to determine a driver's tendencies from his accident record alone: A poor driver may be fortunate enough not to run into accident situations, and the good driver may be cursed with more than his share of them. In any event, it was found that the most important element in taking chance out of driving is "skill in avoiding accidents when in dangerous situations."

ALTHOUGH statistics show that in about 90 percent of accidents it is the driver rather than the car which is at fault, the Survey included in its report an analysis of automobile construction in relation to safety. This should prove of special helpfulness to persons looking at the new motor cars with intentions of buying. Professor Dean A. Fales, who made the automotive study, included the following among his observations:

"In some of the newer cars with very high and small windows, the effort needed to give proper hand signals is so great that the operator will tend to neglect them. Some of the electric signaling devices and semaphores that are used to a small extent here have been developed and are used largely on European passenger cars.

"Windshields should be kept clean at all times, especially so during the twilight hours. It is suggested that drivers should clean their windshields as evening approaches.

"It is believed that one of the outstanding developments needed is a satisfactory windshield defroster.

"The sloping windshields give better upward vision, but before we can consider that our traffic vision is satisfactory, we shall have to consider sloping the engine hoods downward toward the front of the car.

"For the average operator it would seem that the instruments (on the dashboard) could be replaced by telltale lights, as has been done on some cars. These dashboard signals warn the driver only when something is wrong, and the only instrument he need watch is the speedometer.

"The foot throttle must be placed in a convenient position where no fatigue is suffered from its operation. Too many foot throttle controls are made too cheaply.

"The roadability and directional stability of a car has much to do with its safety. Some cars are unsafe to drive over 40 miles per hour because of poor road-holding qualities, poor steering, and poor riding characteristics.

"Building a car to be stable in cross winds is of more importance from the safety standpoint than true streamlining, as a motor vehicle has to have its wheels on the ground and does not always head directly into the wind. A cross wind of over 40 miles per hour can make some of our lighter cars unsafe at speeds of over 50 miles per hour.

"The power plants in the past two or three years have been developed to a point where the accelerations and top speeds are far greater than the brakes, steering, and road-holding abilities can safely handle.

"Tire chains are of definite value in gaining traction in snow, mud, etcetera, but they also are a hazard. On glare ice, or on wet hard ice, tire chains can cause more skidding and sliding than without their use.

"Such inspection figures as are available indicate that lights and brakes are the parts most frequently in faulty condition."

FROM our brief glimpse of some of the highlights of the Massachusetts Highway Accident Survey, it can be seen that such information as the New England surveyors have gleaned from the vast field of their operations can be of great help in assisting motorists everywhere to make their driving less dangerous. But there is another factor in the accident situation which needs serious consideration. That is the attitude of motor-car operators towards others on the road.

The kindly, considerate driver, equipped with proper machinery and a knowledge of the rules of the road, is the least likely to be the cause of an accident. Take the proper attitude away—leave him with only his fine machinery and driving experience, and he may become a real menace. If you are selfish, unthoughtful of others, fail to co-operate, and act as though the road is your exclusive property, you might as well be dead for all the use you are on the highway. And the chances are you will be dead before your time.

Boiled to its essence, this matter of attitude comes down to the old Golden Rule. If you always drive as you would have others drive, you'll be contributing 100 percent towards a reduction in the accident toll. Of course, you must first have a safe car and know how to operate it, but of greatest importance is that you treat other motorists as you would have them treat you. Just think of that on the road some day. Notice how few *do* think of others, and how gratified you are when some occasional driver does show you the courtesies you deserve. If you can only thwart that temptation to be avenged on the road hog, and be a courteous driver whatever the sacrifice, you will have gone a long way toward building that future army of careful drivers which alone can make the highways safe. The value of your good example is often greater than the apparent worth of your good turn at the moment of its performance. Courtesy will continue to pay!

Testing Steels by Sparking

By DE BARY KERSTON

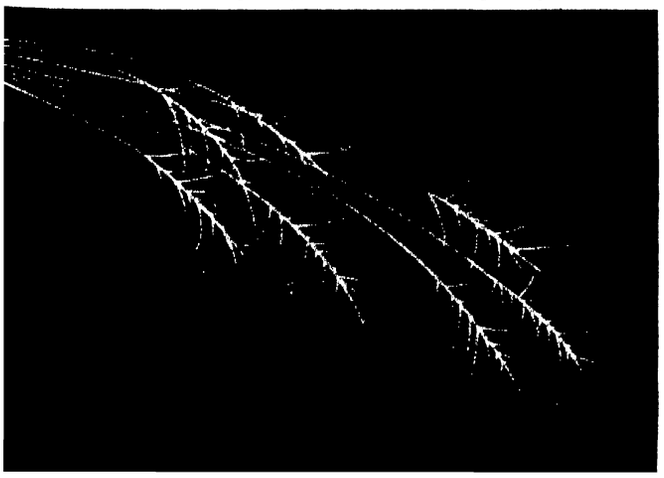
r lines for ingot iron sparks are smooth, but from a 0.15 per-
arbon-steel some of the lines are forked with smooth branches

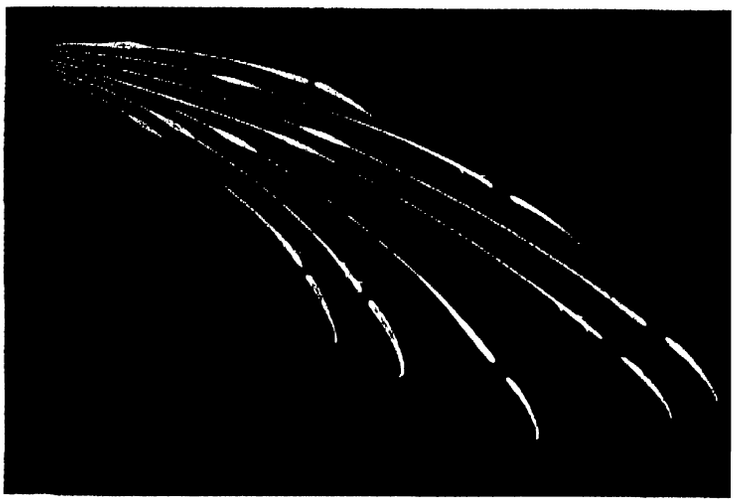
As everyone knows, a piece of iron or steel becomes coated with rust after a while, which means that it forms a union with the oxygen from the air. This, in reality, constitutes a long drawn-out oxidizing, or burning, process. The same thing happens instantaneously, and much more effectively, when minute particles of steel or iron burn in the air.

Far more spectacular, however, are such sparks made by holding a piece of steel against a grinding wheel. Close observers of this phenomenon have found that the form and the coloring of the sparks, as they fly through the air, vary with the composition of the steel or iron.

If the metal is iron, the result appears to be a small sheaf of single lines. If a piece of carbon steel of about 0.15 percent carbon is held in contact with the wheel, the color of the line is lighter and the presence of a number of short single forks, or primary bursts may be noted. These forks or bursts are undoubtedly caused by carbon embedded in the steel.

identification of 0.30 percent carbon steel. The relation of
rbon content to the frequency of bursts may be plainly noticed





The characteristic spark of molybdenum steel is an orange-colored spear point—always present but broken away from each carrier line

The relation of carbon content to the frequency of the bursts also marks carbon as the element responsible for the forking of the trajectory or carrier line. A 0.15 percent carbon steel exhibits a slight forking effect; a 0.45 percent carbon steel, a pronounced burst; and steel in the neighborhood of 1.00 percent carbon, a minute explosion. Moreover, there is greater intensity of bursting with an increase in carbon.

Steels, alloyed differently, but with the same carbon content, are not always so easily identified. The burst is the characteristic spark of carbon. Other elements have distinctive characters. One of the most easily recognized of all is that of molybdenum, which appears as an orange-colored spear point on the end of every carrier line. Other features of the molybdenum spark are that the spear points are detached from the carrier lines and are always present regardless of the length of the lines.

Nickel gives a characteristic spark, identified as tiny blocks of brilliant white light. When present with molybdenum in a steel alloy, nickel partly suppresses the carbon spark.

Minute explosions in sparks from steel with 1 percent carbon. Steel with 0.45 percent carbon gives off sparks with a pronounced burst

Silicon, likewise, suppresses the carbon spark to a marked degree. The carrier line from silicon steels is much shorter than from a plain carbon steel of the same carbon content, and generally ends abruptly in a white flash of light.

The dull red spark of high tungsten steels is well known to all who have dressed high speed steel tools.

Admittedly, spark testing is not a substitute for chemical analysis, and is not intended for the identification of unknown samples. One of the advantages of the test is that it can be applied to steels in practically all stages of production. Since it is done directly on the pieces themselves, expensive sampling is avoided.

HYPNOTISM

Is Not a "Mystic Force" . . . Is Akin to Sleep-Walking and Insanity . . . Mainly of Use to the Psychologist . . . Other Uses are Very Limited

By G. H. ESTABROOKS
Professor of Psychology at Colgate University

ONCE I won a bet. It happens so seldom that this particular occasion has always stuck in my mind. The bet dealt with hypnotism and its relation to crime. So one day, having duly warned my opponent, Mr. X, that he would lose his five dollar bill within the month, a friend and myself stopped in for tea. A pleasant time was had by all. That evening I called and collected the five dollars, for the chap who accompanied me to tea had been deeply hypnotized all the time, and Mr. X never detected it. Moreover, my friend swore up and down that he had not been to tea at all but had been playing bridge with a Mr. Y, 40 miles away. Furthermore, Mr. Y swore this was a fact—he also was a good hypnotic subject—and they both believed it. A nice little tangle for a jury to unravel if a crime had been committed in Mr. X's apartment that afternoon.

WHAT is hypnotism? It is not a mystic force flashed over hundreds of miles by the power of some dark hypnotic eye. A hypnotist may be a pure nordic and he doesn't even need long hair. In fact, so commonplace has hypnotism become that we now do a great deal of our work by means of a phonograph record. The best analogy we have with the hypnotized person is that of the individual who walks in his sleep. We call the sleep walker a somnambulist and refer to his condition as one of natural somnambulism. The deepest stage of hypnotism we term artificial somnambulism. In fact, if you can find a person who is walking in his sleep, and can start a conversation without waking him—it can be done at times—then that person is hypnotized just as effectively as if the work were done by the best psychologist in the country. You are in touch with the unconscious mind of the subject, which is just as capable of handling the body and is just as acute as is the individual's conscious mind.

How is hypnotism induced? Obviously we can't wait until we find someone walking in his sleep. As a matter of fact we use a very simple technique, described in any good book on hypnotism such as "Hypnotism" by Moll or "Suggestive Therapeutics" by Bernheim. The subject reclines on a couch and the operator "talks sleep" for five or ten minutes. If this is repeated several times we find that about one out of every five or six adults will literally go to sleep and keep on talking in their sleep. We should add that women are no more susceptible than men, despite certain notions as to their love of talking.

This simple technique puts you in touch with the unconscious mind of the subject, which explains the spectacular results which are obtained. First of all, this unconscious mind is extremely suggestible. By that we mean it literally tends to believe anything it is told. The critical faculties are largely wiped out, so that if you tell the individual that he is Alexander the Great, that you are King George, or that Mussolini is a pacifist, it is quite satisfactory to him. He accepts the statement and behaves accordingly.

But suggestion is only the key by which we unlock the real mysteries of hypnotism—for they are mysteries, not in the sense of being supernatural but because we just cannot see how the unconscious mind can do such strange things with the body. For example, we can always get "hallucinations" in any good hypnotic subject. These we define as false sense impressions and they can be obtained in any of the senses. I tell the subject that there is a pink elephant standing in the corner of the room. He sees and describes it. Similarly he can be made to hear the Metropolitan Opera, taste the most glorious wine, or smell a skunk next door. He will shiver with cold or protest that it is suffocatingly hot, all within a minute's time and in the same temperature. Moreover, and closely akin to these phenomena, he will mix things up. Soap will pass for chocolate, if you tell him so, ammonia for eau de Cologne, and the whine of a motor engine for a college band.

THEN we can produce anesthesias in a good subject. Tell him there is no feeling in his hand and you have a stick of wood. You can prick it with a pin, burn it, even amputate a finger without pain. In the old days they used to perform major operations under hypnotism. This was before the time of ether and chloroform, which rapidly replaced hypnotism, owing to their greater convenience and greater certainty.

Not only can we remove the sense of pain by suggestion but we can treat any other sense in a similar manner. Blindness can be so produced, as can also deafness. The sense of taste can be completely obliterated and the strongest ammonia pass unnoticed if held before the nose. We shall see later that these conditions are closely related to certain mental disorders such as hysteria and shell-shock.

PARALYSES of any muscles in the body are easily produced. Suggestion can render an arm or a leg useless, while the whole talking apparatus can be similarly paralyzed.

One of the interesting and instructive phenomena in hypnotism, as it ties in with our study of mental disorder, is the delusion. This type of mental reaction can be obtained in the most interesting and absurd form. Tell an individual he is Napoleon and he behaves as such, imitating the character far better than he could do in his normal state. He will take the part of inventor, gangster, college president, or garage mechanic, on demand. What is far more important, he is not only acting a part—he believes it. He *is* the individual in question and defends his identity with the same heat that you would display if anyone questioned your right to your own home. Two of us spent one hour cross-questioning a man of 25 who claimed he was a captain with the American forces in the last war. He was seven years old at the time. Then we gave up. He still stuck to his story, so the delusion was removed with no ill effects.

It is a very curious fact that the working of body organs can be controlled in hypnotism. A very good subject is required for these experiments, but the heart beat can be hastened or retarded, body temperature can be raised or lowered in some cases and digestion inter-

fered with. Indeed, some go so far as to claim that bleeding can be produced in any part of the body by means of suggestion, and that blisters can be raised simply by applying a postage stamp and assuring the individual it is a mustard plaster! Such claims are as yet not proved to the satisfaction of psychology, although there seems to be a reasonable chance that they may be true in the case of a few very excellent subjects.

Bergson quotes an unusual case. He had a very good hypnotic subject, a boy of 12 who could do the following stunt: The subject would stand facing Bergson, who would hold an open book *behind* the subject's head. The boy, according to Bergson, would then read from the book. Bergson at first thought this was an example of mind reading, since he also read the book at the same time. It turned out that the subject was *reading the reflection of the book in Bergson's eye.* This would require a keenness of vision which would be microscopic. Such reports are rare and cannot be accepted without further proof.

There does seem to be little doubt but that we do get a definite increase in muscular strength during hypnotism, especially in terms of resistance to fatigue. An individual can really show amazing physical endurance but this has not the obvious application you may think. It would be very foolish, for example, to have an athlete break his mile record—and die of heart failure. Your body is a machine and fatigue is simply the warning whistle which tells that the gas is running low. Disregard it and the machine may suddenly stop.

FINALLY, the individual, when hypnotized, has a remarkable memory for events which he has long since forgotten. This is a very curious thing and of great importance to psychology, since many cases of mental trouble are based on experiences of childhood. It is a very strange thing that an individual in the hypnotic trance can recall the events of his early years which have long since slipped from his conscious memory. This method of delving into the unconscious we call "hypno-analysis." Linked with the technic of psycho-analysis, it sometimes yields excellent results in curing some mental ailments.

Hypnotism, in and of itself, has a certain interest to psychology but its great importance is due to the light which it sheds on the so-called functional nervous disorders. So great is its use here that we sometimes refer to hypnotism as the laboratory of abnormal psychology. Perhaps our best way of showing this linkage is to proceed as follows:

Every phenomenon that we can obtain in hypnotism we can get by means of the so-called post-hypnotic suggestion. For example, I suggest to my subject that he sees his brother standing in a corner of the room. He does so. But I can also suggest to him that, tomorrow afternoon at three, or two months from today, or next Christmas eve, he will see his brother in that same corner. Strange to say, he will do so. At the time specified his brother will appear before his eyes and he will act in every way as if this person were actually in the room.

JUDGING from letters received at various times by the Editor, there is still some confusion regarding hypnotism. Is hypnotism scientific or pseudo-scientific? Unfortunately, many persons have not seen and do not know of its use elsewhere than on the stage, where it is often surrounded with added "frills" in order to make of it a more entertaining show. That it is used in the psychological laboratory, and has been used by physicians, are less widely known. A good account of these uses will be found in the accompanying article, also in the Encyclopædia Britannica, under "Hypnotism." Even stage hypnotism is not essentially pseudo-scientific. It is not, as many have suspected, a fake or a trick, for it has no need to be, because the genuine is easier to put on than a good imitation.—*The Editor.*

Similarly, we can reproduce any of the curious hypnotic phenomena after the trance, and apparently time is of little consequence. We have examples of these post-hypnotic suggestions being carried out after a whole year's lapse of time—they would probably work just as well after five years. Paralysis can be made to hang over in this manner and the same applies to anesthesias. Delusions will do the same. One subject startled a group by announcing that he was Lenin restored to life and called to head a Bolshevik revolution in America. A psychiatrist present—it was all for his benefit—was ready to swear as to his insanity when the post-hypnotic suggestion was removed and the doctor realized he had been "framed."

These suggestions have two very curious characteristics which are worth noting because of their bearing on mental disorder. First, the subject will always rationalize. He never knows why he acts as he does, but will always give a plausible excuse for his actions—and he believes it. If he finds himself singing the Star Spangled Banner, it is because he heard it played that morning. If he deliberately breaks his cigarette holder it is because he cut his lip on it yesterday, and if he has a sudden impulse to leave for New York City it is because he promised a friend three months ago that he would meet him in the Grand Central Station tomorrow morning—and believes it. Very rarely will he realize that his actions are the result of a suggestion given in hypnotism.

Secondly, the post-hypnotic suggestion acts with a peculiarly compulsive force. It *must* be carried out. If the subject is told to occupy a certain chair on a given signal he will do so. If someone else is in the chair he will insist on his getting up, even going to the extent of physical violence if necessary. One of the most curious of these developments is to give the subject such an order, then tell him that it is a post-hypnotic suggestion and dare him to resist. I have collected several bets from subjects who thought they could do so. This compulsive power of the post-hypnotic suggestion, as well as the subject's tendency to rationalize, bear a striking resemblance to the symptoms in some nervous disorders.

WE must now note a further development. Anything which you can get in hypnotism or in the post-hypnotic suggestion you can also get by means of auto-suggestion. This is simply the technic of relaxing into a drowsy state and talking to yourself. Do you recall Coué's famous formula: "Every day and in every way I'm getting better and better"? That contains the general idea. (By the way, when Coué returned to Europe he said this formula was of little use in America. It took too long to say. Americans just cut it down to "Hell, I'm well.")

But if you develop the technic as described by Coué or by Baudoin in his "Suggestion and Auto-suggestion," you can actually get not only suggestions but post-hypnotic suggestions by means of auto-suggestion. It is very curious, for example, to awaken at 2 A.M. and listen to an orchestra, all the time fully conscious that it is the result of your suggestion to yourself before going to sleep. When in hospital after the war I had a pet polar bear who would parade around the ward in a most convincing fashion. He also illustrated the dangers of playing with these forces, because he developed the habit of coming uninvited and would not always go home when told, so he was banished forever.

It is here that hypnotism ties in with mental disorder. Anything you get in hypnotism, the post-hypnotic suggestion, or auto-suggestion you can also get in everyday life. You then say the individual has some type of mental disorder, all the way from "peculiarity" to "insanity." Under the influence of strong emotion, especially fear, you are literally

hypnotized. Any impression which strikes your sense organs at that time will give results exactly resembling the post-hypnotic suggestion, for emotion sensitizes the camera plate of the brain.

For example, a soldier in a moment of intense fear had his eyes glued on a German helmet. Result: A case of "shell-shock" wherein the soldier had constant terrifying visions of this helmet and the face beneath. A corporal was turning the elevating screw on a field gun when a shell hit it, killing everyone but himself. Another case of shell-shock in which the soldier could not stop his arm from rotating, for this activity was uppermost in his mind at that moment of intense fear. A child finds himself locked in a narrow alley with a dog which attacks him. The result in later life was claustrophobia or a fear of closed spaces, since the idea of escape was uppermost at the time. Another child is badly frightened by a man with red hair. As an adult he developed a "compulsion neurosis," in this case an irresistible desire to strike every red headed man he saw.

You will note that results here are a little different and the technic is not the same, but if you will just bear in mind the fact that under strong emotion the individual is, to all intents and purposes, hypnotized—witness the bird and the snake—then you can see that all these symptoms of "insanity" are really "suggested" and are first cousins to the post-hypnotic suggestion. For that reason the study of hypnotism is of tremendous importance to the medical profession.

THESE facts being as they are, what does it all mean to the reader? Exactly the same as an article on medicine, engineering, aeronautics. In other words, don't start "experimenting." Hypnotism in the hands of an expert can do no harm. Used by an amateur it may do a great deal. It is a nerve-racking process to have a subject just refuse to wake up, or develop hysterical symptoms after awakening, or insist on going asleep again whenever you glance in his or her direction. Any suggestions of immoral or anti-social nature, even if given merely as an experiment and rejected by the subject, involve strong mental conflict. Then the subject may easily become so susceptible to hypnotism that he will go into the trance for anyone. These problems and others are easily met by the trained operator but may get the amateur into serious difficulty.

Remember also that we have no sure method of telling whether or not a person is hypnotized or is just bluffing. I have seen some ludicrous performances in college, where a good student actor proceeded to "take across" the student hypnotist. One such séance ended in the "subject" pursuing the operator all over the campus with a carving knife, to the huge delight of everyone. On another occasion the subject was made to pose on a chair, as the Statue of Liberty, while the hypnotist pulled the hairs out of his leg one by one, to prove he was hypnotized. This was too much for even the best of good natures and the Statue's arm suddenly dropped on the operator's head with painful results.

AS the author states, hypnotizing is not a safe kind of experiment for the average layman to perform, and the damage, if done, is done to a difficult thing to repair—a human being. In presenting the accompanying article this magazine dissociates itself from all responsibility for injuries which may result from misuse of its content.—*The Editor.*

There is not much danger from criminal or immoral suggestions. Authorities in general agree that the subject will do nothing against his moral code. You must bear in mind that the unconscious mind is very keen. It can do mathematics, write poetry, or memorize history quite as well as the normal mind. The hypnotic subject is also a born actor and will do a great deal to give satisfaction. Give him a rubber knife, a suggestion of murder and he is most convincing. Ask him to forge a check and he will do so. He knows it is a joke and plays the part. Give him a really immoral suggestion and, provided he is a moral individual, one of two things happens. He gives you a point-blank refusal or he wakes up. The hypnotic subject very definitely has a will of his own. He may allow you certain liberties but the dead-line is always very distinct.

Hypnotism is then a condition closely akin to sleep walking. The unconscious mind is in control of the body. In the hypnotic trance, however, this unconscious is also in touch with an operator. This accounts for the curious results, for the unconscious is very open to suggestion and has a remarkable power over the entire body. It can produce visions, anesthetise an arm, paralyse a leg, eliminate fatigue, or regulate the heart beat. In addition it is quite as keen as the conscious mind when it comes to mathematical problems or writing—very easily its superior as a play actor. And the hypnotic subject likes nothing better than to perform fake murders or write "phoney" checks for the psychologist will tell you that the unconscious mind is a childish mind, with all the child's love of "show off."

The practical uses of hypnotism? Really very limited. Several students have made the bright suggestion that I hypnotize them and make them do their studying while in this state, with the suggestion that they remember everything on awakening. If laziness is the mother of invention, America is going far, fast. Equally brilliant is the suggestion that the student write his examinations while hypnotized. Now that I come to think of it, some of my own pupils may have tried this. They certainly were not noticeably conscious.

Seriously, hypnotism has no great practical use. As an anesthetic it can never compete with the various drugs. I have seen some very excellent work done on alcoholism and drug addiction in general. Also some very good, as well as some very discouraging, results with stammering. It certainly is no cure-all, and the wild claims of some enthusiasts are based on inexperience.

THE great use of hypnotism lies in the field of research, for with its aid we can reproduce most symptoms of insanity and study them in the laboratory. Our need here is much the same as in medicine. The problems of research are greatly simplified if the germs of tuberculosis or typhoid fever can be grown in the laboratory *outside* the human body. We can then work at our leisure, without worry as to the individual sufferer. Hypnosis brings the symptoms of insanity into the laboratory. We can study these also, in our own way, without fear of producing or aggravating any mental trouble.

But bear in mind that hypnotism, like many things, is only safe in the hands of the expert. The story is told of an old darky who was sent out to Paris-green potato bugs. It was the first time he had ever seen the poison, and half an hour later he was found rolling over on the ground in great pain. It seems that one of the bugs had flown down Sam's throat and he promptly drank a cup full of Paris green to kill the offender. Your own treatment of symptoms by hypnotism might be just as crude and ludicrous, for the human mind, like McGinty's mule "ain't near as simple as he looks."

Leave hypnosis to the psychiatrist in the hospital. He has both the knowledge and the facilities. Many colleges and universities have a rule against its use within the walls. It is so at my institution. While there is no danger attached to the use of hypnotism by an expert, there is, nevertheless, a very natural prejudice against its use in certain spheres. Where the prejudice exists, it should be respected. Hypnotism has been unfortunate in that it has been too often associated with stage performances. While these are not of necessity fraudulent, many of them can hardly be called elevating or scientifically valuable.

POWER IN THE WILDERNESS

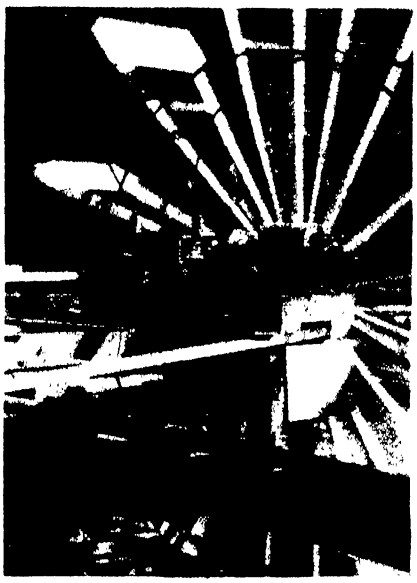
Ingenious, Inexpensive Power Plant is Example for Remote Camps, Lodges, Resorts

By WILLIAM BENJAMIN WEST

A COMBINATION of old automobile parts; a few timbers; a homemade, undershot water wheel; and a small, used, D.C. generator in conjunction with a flume and dam of timbers and stone has been set up to provide electricity at a small vacation resort on the Cahaba River, near Birmingham, Alabama. The resort is five miles from a power line and the owner wanted to "harness" the nearby rapids at minimum cost.

The site selected embraces about 100 feet of river bed in which there is a fall of about three feet, the bottom being ledge rock with strata protruding at irregular intervals and slanting upstream at an angle of about 30 degrees, and running all the way across the channel.

During a part of the year, a sufficient volume of water flows in the stream to operate an undershot wheel even if no diversion works had been provided. However, in order that most of the water might be concentrated at the wheel during low river flow, a low diversion dam was constructed across the river at the head of the rapids and a flume line run along the shore to the wheel pit. This dam is of rock-crib construction, the cribs being built of oak slabs with field fence or "hog wire" securely fastened over the bottom of each pen before it was carried to its location and filled with rocks. The spaces between these pens are closed with removable horizontal boards. The canal is also of timber construction and is securely anchored.



Close-up of generator and motor-car parts of homemade power plant

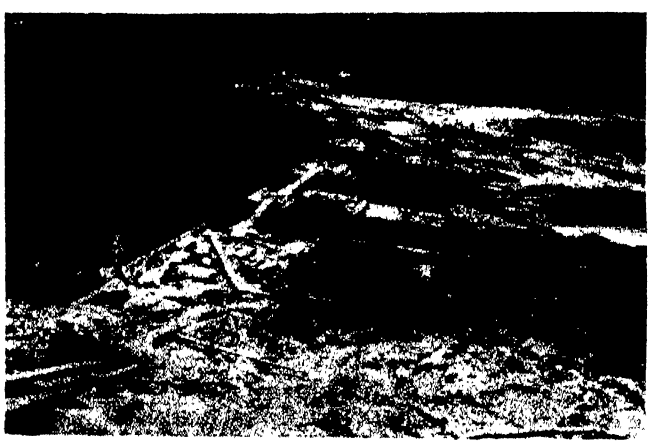
The water wheel is the feature of this undertaking. Two poplar logs, each about 10 inches in diameter, were secured to two trees near the water at the foot of the rapids. These logs run nearly parallel with the river. Across them two four-inch by six-inch timbers, each 18 feet long, were placed 18 inches apart, center to center. Across the outer ends of these timbers, which hang over the wheel-pit cut in solid rock, two short lengths of railroad rails were securely bolted at such spacing as to fit exactly into the spring saddles of an old Hudson automobile rear axle. The rails were machined on top to meet the curvature of the saddles, and dowel pins were sunk in place to prevent slippage between rails and the rear axle housing.

The axle was placed with the right rear wheel over the wheel pit. The left wheel was securely fastened by clamping on the brake. White oak pieces, each three inches by two and one quarter inches by six feet eight inches, were securely bolted to the right wheel to form the water wheel. The "buckets" used were ordinary boards.

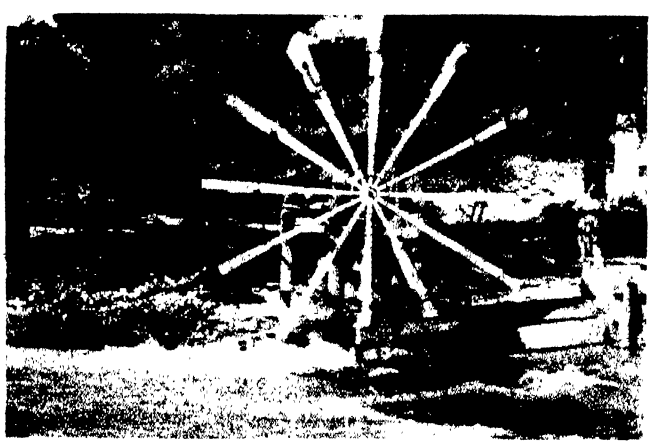
WITH this arrangement, the water wheel turns the drive shaft of the old Hudson rear end. The ratio of the differential happens to be 3.5 to 1. On the power shaft pinion, the large gear of a Mack truck chain and sprocket set was secured. The small sprocket is attached to the rear end of a Chevrolet transmission, the front of which, in turn, is connected to the rear of a second transmission box, both transmissions being securely anchored across and above the old rear axle housing. The chain and sprockets have a speed ratio of 3:1. The two transmissions in series, driven from the back, have a combined speed ratio of 18:1, thus bringing the generator up to speed.

The size of the wheel permits operation during most floods, but the wheel-supporting timbers are hinged to permit raising the wheel when desirable.

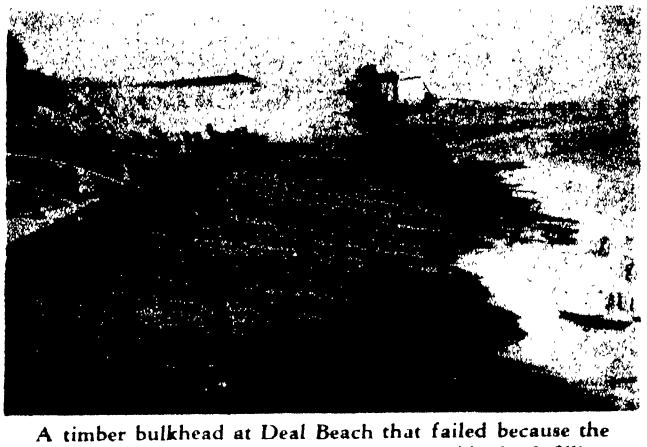
The cost of the water wheel, used automobile parts, timbers, hardware, a used 110-volt D.C. generator, machine work, and labor was approximately 75 dollars. This did not include the owner's time in building the wheel itself, nor the cost of the dam and canal. The whole job cost an estimated 150 dollars.



The low dam and part of the flume that leads down stream to the site of the undershot water wheel and power plant



A view of the water wheel as seen from the opposite side of the river, showing also the lower end of the wooden flume



A timber bulkhead at Deal Beach that failed because the structure was not supported by a suitable back-filling

By contrast—a fine new sheet piling bulkhead at Deal Beach supported by timber bracing and wide back-fill

ENGINEERS COMBAT THE SEA

New Jersey Studies Coast Erosion...Great Economic Loss...Varied Problems...How Approached...How Solved . . . Findings Helpful to Others

By R. G. SKERRETT

NEW JERSEY is waging war along a battlefront of 125 miles. Her conflict is with Nature; that is, with the Atlantic Ocean which is continually attacking her seashore from Cape May northward to the tip of Sandy Hook. This ceaseless battle is for the defense of menaced properties that have today a combined taxable valuation of more than half a billion dollars.

What New Jersey has done and is doing to protect her exposed seashore should be of interest both to other states and to that great number of our people that annually go to those surf-swept beaches for recreation, rest, and recuperation. Those beaches are patronized by millions of our citizenry living within a radius of fully 500 miles inland. Railroads and fine motor highways make that playground readily accessible. The visitors linger anywhere from a day to a matter of months; and to supply any and all with the conveniences, comforts, and diversions they expect, there has evolved on a truly splendid scale, from Sea Bright south to Cape May, what has been aptly termed "the resort industry."

Along this extensive ocean front there are cottage colonies, townships, and cities; most of the larger communities are thoroughly organized and boast fine hotels, diversified shops, restaurants, and places of varied amusement. The vast majority of these are located on what was a veritable sandy waste, of very little likely value 50 years ago.

The first-comers naturally sought locations that would afford an unobstructed view of the ocean and assure at the same time a suitable beach for bathing. Most of those people believed that they had chosen their sites wisely. Later arrivals, in their turn, also bought as near to the water front as possible. It is fairly certain that a large percentage of those people would have hesitated to spend money on shore properties for their own use if they had studied some of the old maps of that same seaboard.

MAPS made at different times over the last 100 years reveal that within that period certain shore fronts have been built up to the extent of 3025 acres, while the same forces have removed either at those points or elsewhere along the seashore a total of 5220 acres—the net result being a loss of about 2200 acres. The economic significance of these changes would be trifling if the resort industry had not made of the New Jersey shore front what it has. The problem now is to arrest erosion wherever practicable or to minimize it as far as possible. Bitter experience has proved that this cannot be done in most situations by rearing barriers that are counted upon to oppose by sheer structural strength the battering attack of storm-driven waves. Enlightened engineers now know that success is to be won only by resort to strategy—strategy that either diverts the ocean's attack or robs that attack of much of its power to do damage. Indeed, these experts have found ways to lure the ocean to upbuild the beach just where it had previously cut into the shore line. The general public may not be aware of it, but the coast of New Jersey has become a great laboratory for the study of coast-erosion problems that are world-wide in their significance and certainly recurrent at many places along our seaboards and the shores of some of our great inland lakes.

In the past, property owners and seashore communities have spent millions of dollars in erecting barriers of one sort or another at various points. Not infrequently, those defenses have been conceived and built without a sufficient understanding of the basic physical actions they were designed either to arrest or to modify. This unconsidered procedure, with the losses entailed, is responsible for a fairly widespread belief that beach erosion is inevitable and that it is futile for man to try to combat it. Happily, this gloomy attitude is unjustified; the experts of the government and of New Jersey are proving that the fight for protection can either be won convincingly or the advance of the sea upon the land can be slowed down to a marked degree. Success, however, is contingent upon careful study of the controlling conditions at each situation, day in and day out, in all kinds of weather. These circumstances must be taken into account anywhere, and are not peculiar to the New Jersey coast.

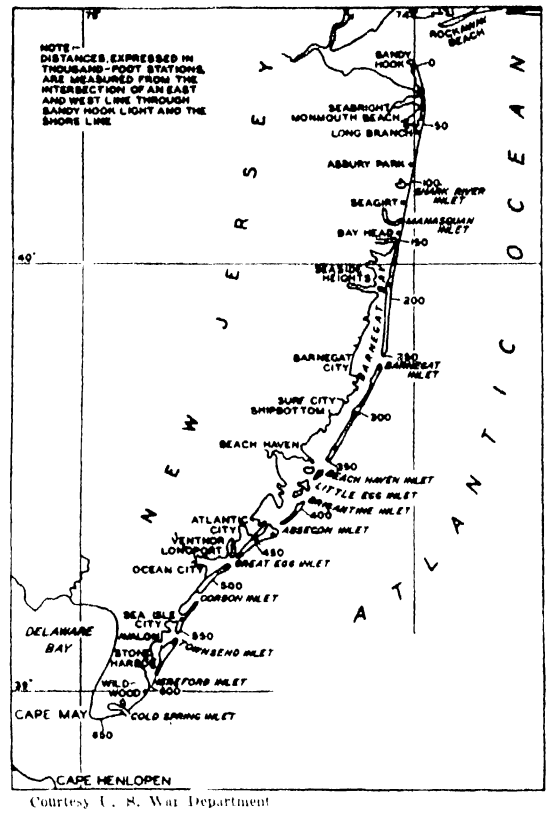
Broadly stated, sandy beaches are of two sorts—they either slope abruptly seaward, or they extend farther out from the shore because of their comparative flatness. Each type offers a different

problem in protection. The northern beaches of the New Jersey coast slope abruptly while the southern beaches of that state dip gradually. The northern beaches, because the water is fairly deep close to the shore, are directly exposed to the pounding attack of full-bodied waves urged on by storm winds. The southern beaches, on the other hand, have a broad belt of shallow water lying between them and the ocean, which serves to trip the oncoming waves and to cause them to break, thus robbing them of much of their power to damage before they reach the shore. Manifestly, the strength of the inshore defense against storm waves must be greater at the northern beaches than at the southern ones; and the same is true where the primary purpose of a defensive structure is to obstruct the free sweep of currents that are mainly responsible for the denuding of a beach at one place and the upbuilding of another beach at some point beyond. Due regard must be given not only to the range of velocity of such currents but to their prevailing direction. The attacking forces that both make and destroy beaches are waves and currents produced by winds, and this is especially true of local winds as distinguished from occasional storm winds.

THE seashore of New Jersey is composed of beaches of two types—namely, the headland beach and the barrier beach. The headland beach is the eroded water front of the mainland; the barrier beach is a narrow strip of sand lying more or less offshore and parallel with the mainland, with a sheltered body of water between it and the mainland. The barrier beach constitutes a battlefront that lacks the immediate support that the headland beach possesses. The barrier beach is more susceptible to the action of waves and currents; the continual fluctuation of the ocean front of such a beach is a ceaseless reminder of the forces that brought it into being and which may still add to it or withdraw from it at any time some of its sandy mass. It just happens that the New Jersey seashore is mostly of the barrier beach type.

Generally speaking, the seashore defense structures now used may be grouped in two classes. These are sea walls, or bulkheads; and jetties, or groins. To prevent confusion, we shall use only the terms "bulkhead" and "jetty." Bulkheads are reared at the inshore limits of a beach and parallel with a beach, and their purpose is to halt the frontal attack of storm waves. Jetties commonly extend outward across a beach from a bulkhead or a bluff shore, and usually to a point that is not uncovered at low tide. The jetties are intended to arrest erosive currents that sweep parallel with a beach or meet it diagonally. Waves or currents that strike a beach diagonally do more damage than waves advancing upon the beach perpendicularly or currents moving parallel with a beach.

The engineer must adapt his defenses to combat those conditions that prevail most of the time, and this is especially true in the case of jetties that are designed to arrest erosion, which takes place in fair weather and foul. Wet sand flows readily, and seas and currents can pick up that sand and transport the suspended particles considerable distances. Sand so moved, depending upon the size and weight of its particles, is precipitated later as the water currents lose their speed. In this manner, a beach is progressively reduced and the sand carried off is dropped elsewhere to upbuild. This process may bring about momentous alterations, varying with the strength of the eroding forces and the time they are active. If the sweep of sand-laden waters can be slowed down, then the sand will be caused to settle and a beach will begin to form or be extended. The function of a jetty is, accordingly, twofold—to arrest erosion and to increase the expanse of a beach. The seashore of New Jersey exemplifies how this can be done provided the jetties are sufficiently durable and dimensioned to meet the circumstances at their respective locations. Similarly, bulkheads will withstand the frontal assaults of storm waves if they are built to meet those blows and are not exposed to the undermining actions of water that may weaken their foundations or impair their immediate and necessary backing.



Courtesy U. S. War Department

Many resorts are located on the narrow offshore barrier beaches of New Jersey

Bulkheads are variously built of timber throughout, of a combination of steel sheet piling and timber, or of concrete and timber. In any case, these wall-like structures are invariably braced on their rear sides and further stiffened against the shock of impacting waves by a backfilling of rock or earth or both. The backfilling must be done to prevent infiltrating water from weakening it. Lacking a satisfactory foundation and proper backfilling, no bulkhead can survive long against the insidious effects of permeating water and the direct onslaught of full-bodied waves. In recent years, interlocking steel sheet piling has been used more and more

Where lack of proper and united efforts has led to the virtual disappearance of the beach that prompted a costly development of these seashore properties

Shore front at Long Branch showing well-backed bulkheads with jetties into the ocean

in building bulkheads for shore protection. Besides its inherent strength, the interlocking piling can be sealed to make it acceptably tight against the intrusion of undermining water. The relatively simple timber bulkheads of former years are rapidly disappearing along the New Jersey coast because of their inherent short-comings and because of the attacks of marine borers that bring about their destruction.

There is no fixed type of jetty that will answer under all conditions, for the engineering experts have found that each jetty must be designed with regard to the special circumstances of its situation. At Sea Bright, for example, where the beaches dip sharply, one section of the shore is defended by a massive jetty composed of large chunks of hard rock. That jetty extends out beyond the low-water line and it crosses the beach somewhat obliquely the better to intercept and turn aside the prevailing erosive currents, and also withstand the pounding of heavy waves. This veritable breakwater has caused the upbuilding of a beach that was being progressively carried away and it also checks storm seas that threatened to cut a breach right across the peninsula. Again, at Sea Bright, there are sections of the much exposed shore that are now shielded from the direct attack of storm waves by frontal barriers formed of massive slopes of rock. The same sections were unsuccessfully defended previously by timber bulkheads.

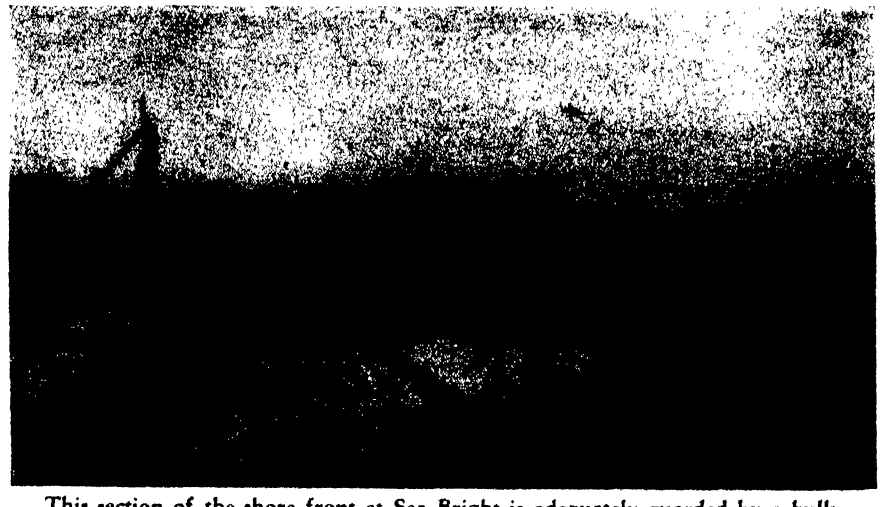
EXPERIENCE has seemed to warrant the belief on the part of the state engineers that even these man-reared promontories of rock should be built with an impervious backbone or core to arrest the passage of forceful currents or jets of water, which are likely to do damage to the adjacent beach and possibly lead to the undermining and settling of the jetty. Core walls can be formed of small pieces of rock that will pack snugly, of steel sheet piling, or of timber piling and sheeting; but if timber is used, that material should preferably be treated to discourage the attack of the teredo or other marine borers. There are some rock jetties, built without core walls, that are now supplemented by paralleling jetties of steel sheet piling.

Between the main defenses of two rock jetties, comparatively low timber or steel sheet piling jetties can be used to stabilize a re-formed beach or to protect an existing beach from impairment; but the advice of a qualified engineer must be sought to decide where this can be done. Gently sloping beaches can be shielded by jetties of relatively light construction. It should be apparent that jetties, like bulkheads, may be of several kinds to suit different situations; and where the jetties meet the conditions properly, beaches can be restored or created anew, astonishing results often being achieved in even a few months.

The seashore of New Jersey bears evidence of what can be done by recourse to suitable measures; there, too, can be seen what may happen when the forces of the sea are either imperfectly controlled or left free to follow their natural courses. The state of New Jersey initiated a policy of state aid 15 years ago; and since that date the state, municipalities, and other interests have spent substantially 3,000,000 dollars in battling beach erosion. This work has been under the direction of the New Jersey Board of Commerce and Navigation; and that organization has developed basic designs for jetties and bulkheads, susceptible of modification to suit local requirements. Mr. Victor Gelineau is director and chief engineer of that board, and he reports that the structures so developed have proved generally capable of withstanding the attacks of the sea and at the same time have induced waves and currents to upbuild valuable water-front areas. Where a private owner has not the means to provide protection for his particular stretch of beach, he not only jeopardizes his own holdings but he may imperil the property of others, many others. The same agencies that have made the barrier beaches have also made the inlets that link the sea with the lagoons and bays behind those beaches, and the existing inlets have shifted up and down the coast considerably during modern times. It is for this reason that some of the inlets are today flanked on both sides by rock-formed jetties that reach seaward for hundreds of feet.

THE Corps of Engineers of the United States Army and appropriate agencies of the various states on the Atlantic, Pacific, and Gulf coasts, and also on the Great Lakes, are jointly engaged in studying the problems of beach erosion; these technicists, using the New Jersey sea coast as a laboratory, are seeking to unravel some of the mysteries of coastal currents, wave action, and the ways in which the sands of the waterbed are picked up and distributed in alternately denuding and adding to the shore areas. The ultimate aim is to place protection against coastal erosion on a still firmer foundation of knowledge that will give to all engineers engaged in such work data that will guide them in meeting any set of conditions at any given location. In short, an age-old problem is thus being dealt with in a typically up-to-date manner. This research, plus the experience already gained, should prove invaluable in combating storms and forces that annually do a great deal of costly damage.

The mighty Atlantic is ever ready to break through weak points in man-made defenses. Only by eternal vigilance and by the employment of structures of proved efficiency, such as those described above, can the sea's attack be arrested or diverted.



This section of the shore front at Sea Bright is adequately guarded by a bulkhead of rock (in foreground), and a massive rock jetty (in background)

ELECTRICAL FLORICULTURE

Artificial Light Supplements Daylight . . . Of Use in Greenhouse or Home . . . High Lighting Intensities Not Necessary . . . The Results

By LAWRENCE C. PORTER*

High-wattage lamps permanently located near roof of the greenhouse

FOR a great many years man has been studying ways and means of growing better plants, getting blossoms out of season when they will command a higher market price, and finding ways and means of decreasing production costs. Early research was directed toward the possibility of raising plants entirely under artificial illumination indoors where it would be possible to control accurately the conditions of humidity, temperature, amount of light, and so on. It was found to be possible to grow plants by artificial light only, but this required such high intensities of light, more or less comparable to sunlight which may run as high as 10,000 foot-candles, as to be commercially impractical from a cost standpoint.

Courtesy Boyce Thompson Institute for Plant Research

Plants grown under (left) daylight; (right) red; and (center) ultra-violet

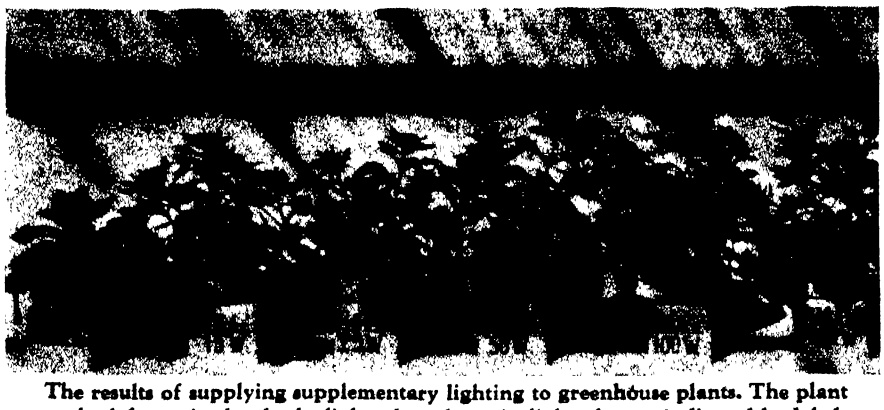
Later research developed the fact that the blooming time of plants is controlled largely by the total number of hours of light rather than by the intensity of the light. For example, plants which bloom in the spring and fall do so because in their natural environment they receive about eight hours of sunlight. Those which flower in the middle of summer do so because they have a total of 14 to 16 hours of light. If it is desired to have plants which normally bloom in the middle of the summer come into bloom in the spring, or even in the winter months, this can be done by supplementing the normal daylight which they receive with five or six hours of artificial light.

It is not necessary for the artificial light to be of high intensity. Intensities in the neighborhood of 10 foot-candles are satisfactory for plants which are grown in greenhouses where they receive the maximum intensity of daylight. In homes where plants do not receive nearly so high intensities during daylight as they do in a greenhouse, the supplemental lighting should be of intensities somewhere between 100 and 300 foot-candles.

Not all plants respond equally well to the same intensities or the same hours of artificial light. An average of results obtained with some 25 varieties of flowers commonly grown for the market showed that supplemental lighting of about 10 foot-candles for four to six hours a day resulted in bringing the flowers into bloom 30 days earlier than those having no supplemental light. There were on an average 12 more blossoms per plant, and the flowers were larger and the stems longer. This supplemental light cost approximately one half cent per flower, which was less than the increased price obtained for these blossoms due to getting them on an early market. The supplemental lighting used was that from ordinary incandescent lamps of the type used for lighting offices and homes.

MANY experiments have been made on the effect of colored lights on plants. Red light tends to make the plants tall and spindly; blue light tends to make them short and stocky. Ultraviolet, contrary to general belief, has been found to be not only unessential to plant growth, but actually detrimental, and the shorter the wavelength of the ultraviolet the more it inhibits the growth of plants. Experiments have been made with neon lamps, mercury

*Illuminating Engineer, Incandescent Lamp Department, General Electric Company.



The results of supplying supplementary lighting to greenhouse plants. The plant at the left received only daylight; the others daylight-plus, as indicated by labels

A new type of greenhouse with the walls built of insulating material

tubes, and sodium lamps. Of these the sodium seems to offer interesting possibilities because of its much higher efficiency. Until further researches and tests have been made with sodium lamps, the regular incandescent lamps are the most practical light sources to use.

Artificial light in plant growth has found its widest application in commercial greenhouses. Until recently small lamps on drop cords were used over the greenhouse benches, these cords being so arranged that the lamps could be raised as the plants grew. The latest greenhouse practice is to use higher wattage lamps permanently located near the roof of the greenhouse. While this practice wastes some light in the aisles between the benches, nevertheless the increased efficiency with which light is generated by the higher wattage lamps more than offsets the loss in the aisles. For example, a 40-watt lamp generates approximately 10 lumens of light for each watt of current consumed, whereas a 1000-watt lamp generates approximately 20 lumens of light for each watt. In other words, a 1000-watt lamp is twice as efficient as a 40-watt lamp. It has been determined also that the higher the efficiency of the lamp the closer the color of the emitted light approaches daylight and the better its effect on plant growth.

SOME experiments have been made in connection with flashing lamps. Apparently if the lamps are on for periods of five seconds or less and then off for a corresponding period the effect on the plants is quite comparable to that of continuous light. The flashing cuts the total current consumption and lamp renewals nearly in half, offering an interesting possibility for economy in the use of lights in greenhouses. No matter what type of lamps are used they should be equipped with efficient reflectors to collect as much of the light as possible and concentrate it onto the plants.

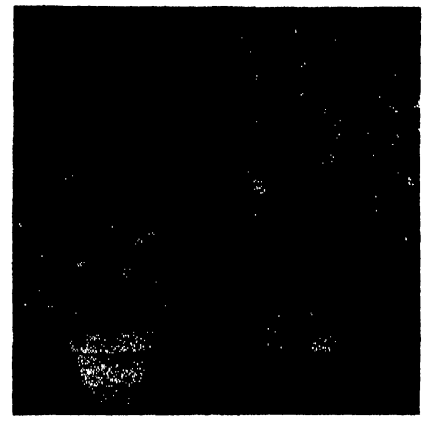
An example of interest to demonstrate the value of supplemental lighting is that of the Santa Clara Ranch in California where botanists are developing new varieties of plants. Before supplemental lighting was used, this process took from three and a half to five years, as the plants had to be grown from seed, cross pollinated, and another crop—sometimes several crops—raised. Since artificial light and soil heating cable were installed to speed up the growth of the plants, this time has been cut approximately in half.

In Sioux City, Iowa, artificial light has been used in growing seed corn. By the use of 100-watt lamps over the plants, corn which was sowed on the 10th of January matured on the 1st of May.

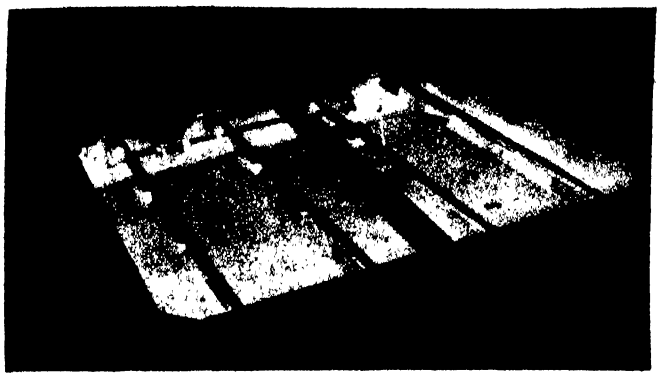
Another interesting development is being carried on at the University of California where plants are being grown without soil. The bulbs or tubers are placed in a layer of straw held on wire netting at the surface of a tank of water which contains chemical nutrients, the roots going down into the water. By this means a much heavier crop of potatoes has been raised than has been possible when the potatoes are grown by the usual method in soil.

Several of the universities have been studying the possibility of growing plants in sand, furnishing the nourishment by means of liquid nutrients.

Perhaps the most interesting development in connection with greenhouses was an experiment conducted at the Boyce Thompson Institute for Plant Research last year. There a greenhouse was constructed in which the walls, floor and half of the roof were made of heat insulating material. There was a single row of glass sash in one side of the roof. This sash was set at such an angle as to admit the maximum amount of sunlight. The interior of the house was painted white to reflect such light as fell onto the walls back onto the plants. The only heat used in this house was that generated by the 500-watt Mazda lamps which were used for supplemental lighting on the plants. These lamps were thermostatically controlled to maintain a temperature of about 68 degrees, Fahrenheit. It was found that even during the coldest winter weather there was sufficient radiant energy in the sunlight coming through the single row of sash to maintain the temperature when the sun was shining. In fact, it was found necessary to open the sash and ventilate on many of the cold winter days. On cloudy days the lamps burned occasionally and during



Left, above, and upper right: **Comparisons of plants grown in an ordinary greenhouse (at left in each photograph) with those grown in the heat-insulated greenhouse illustrated at the top of the page**

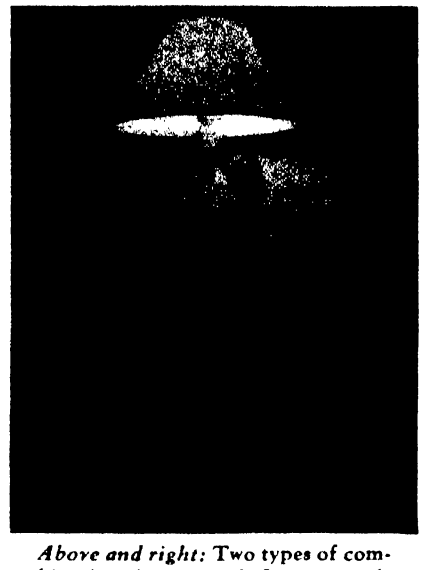


An artificially illuminated hotbed. *Right:* Larger plants of each pair were grown in it, smaller in a manure hotbed

the night they were off and on for periods totalling approximately six hours per night.

The results obtained in this greenhouse were remarkable. Larger and better plants were grown than was possible in the conventional type of all-glass greenhouse. The plants in the heat-insulated house came into bloom in some cases eight weeks ahead of the controls in an ordinary type of greenhouse. It is believed that these experiments may revolutionize greenhouse construction and operation. It may be entirely practical to build greenhouses several stories high. Such houses would be more economical to construct, easier to operate, and would result in large savings where land values are high. Furthermore, this makes possible the construction of small private greenhouses fabricated at the factory and erected quickly and easily by the purchaser at a relatively low cost, since there is no heating equipment to purchase and maintain. The heat-insulated greenhouse enables the maintenance of higher humidity with less watering of the plants. In fact, with thermostatic control of the ventilation, a house of this sort would be almost entirely automatic in its operation, thus requiring a minimum amount of time and labor for its maintenance. There are already two concerns prepared to furnish greenhouses of this type.

ARTIFICIAL light has been successfully applied to hotbeds. Lamps have been used to heat the bed as well as to light it, and they also have been used in combination with soil-heating cable. (See also page 243, May 1935 Scientific American.—*Ed.*) Probably the best effect is obtained where soil heating cable is used to germinate the seeds and allow the plants to secure good root growth. After the seedlings are up, the lights are turned on to stimulate their growth. In one hotbed of this type 16 30-watt lamps were used in a six by six-foot hotbed. These lamps were equipped with aluminum reflectors made by bending up pieces of polished aluminum into troughs eight inches long by two inches wide by two inches deep. The advantage of this type of reflector over the conventional round commercial type reflector is that it does not cut off so much sunlight during the day. The lamps and reflectors are mounted on a simple wooden strip resting on cleats. Each strip is attached to an outlet box by a separable plug so that it may be easily removed when it is desired to work in the bed. The lamps are controlled by an automatic thermostat to maintain the desired temperature in the hotbed. The advantage of a bed of this type over the old fashioned manure heated bed is shown in one of the photographs in which the seedlings in the left hand row were planted at the same time that similar seedlings were planted in the manure type bed. The picture shows clearly the increased growth of the seedlings in the bed equipped with lamps.



***Above and right:* Two types of combination lamps and flower stands**

This same type of lighting equipment is particularly well suited for use in cold frames to protect the plants on occasional nights when the temperature goes below freezing. For this purpose two strips of two lamps each would be adequate for a six by six-foot bed.

There are few people who have the opportunity to use greenhouses, whereas almost every home has plants of one type or another. In the past it has been necessary to keep plants in the home close to the windows in order that they may have sufficient light to grow. The success of supplemental lighting in greenhouses led to the development of plant light fixtures for use in the home. These consist essentially of more or less conventional types of floor and table lamps, except that higher wattage bulbs are used and holders for flower pots have been attached to the fixtures. The latest plant light fixture consists of a semi-indirect floorstand type of lamp using the three-light lamp in which either 100, 200, or 300 watts may be obtained in the same bulb which contains a 100- and a 200-watt filament, either of which may be used separately or both together. This fixture is so designed as to put an intensity of about 300 footcandles on the plants, while the light outside of the area occupied by the plants meets the Illuminating Engineering Society's specifications for good reading intensities, absence of glare, and low intrinsic brilliancy from any part of the fixture in the direct line of vision. Units of this type are not only excellent reading lamps, but they also direct a sufficient amount of illumination up to the ceiling to provide excellent general lighting throughout an average room. The illustration directly below shows one of these combination flower stands and lamps in use.

PLANT light fixtures make it possible to grow plants in the home in locations far removed from the windows. It is necessary to burn the lamps in such fixtures only during the hours they would ordinarily be needed for general lighting purposes, namely from dusk until bedtime. For example, a plant light fixture may be located 15 feet from the nearest window and direct sunlight may never fall on the plant.

MINOR PLANETS — I

Thirty Thousand of Them Are Observable . . . Mass Production in Asteroid Discovery . . . Names For all of These Objects Are Becoming Hard to Find

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society

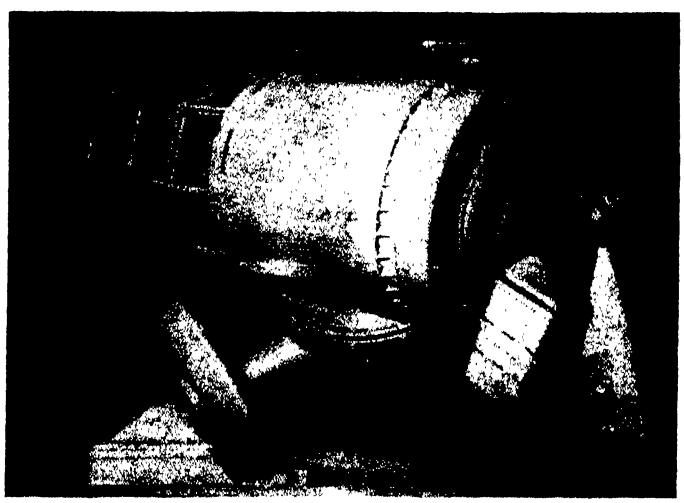
ONE of the difficulties of present-day scholarly work—whether in science or in other fields—is to find out what other people have done already. No one desires to spend his time in working out what has already been proved, or in laboriously collecting data which have already been published and thus put at the disposal of all investigators. But the earlier worker may have published his results—or a more or less adequate summary of them—in one of a dozen languages, and in any of hundreds of periodicals—or perhaps in a separate book, or a pamphlet of which few copies were circulated.

It is a real service to science to collect the scattered data and prepare a summary from which the would-be student may find what has been done and where to find the full account of it.

An excellent example of this has just appeared from the University of California—a volume of "Research Surveys of the Minor Planets," prepared by Professor Leuschner and his associates. Its preparation was no small task. All astronomers, and the majority of well-informed people, generally know that there are thousands of little planets in our system; but few, even among professionals, would have realized that a mere condensed summary of the work that has been done upon them would fill an octavo volume of more than 500 pages.

Even so, this list is confined to the 1091 planets discovered up to February, 1928. A manuscript continuation includes the rest of the 1301 asteroids for which reliable orbits had been computed by the end of the year 1934.

A complete discussion of the minor planets of our system—when and if the advance of observation and calculation might make its preparation possible—would fill not a volume, but a bookcase, for the rate of discovery is still rapid.



The new reflector for the McDonald Observatory in Texas, just completed by Warner and Swasey, as mentioned on page 115. The mirror, according to the makers, is either 80 or 82 inches in diameter (both dimensions are given), and the blank is Pyrex brand glass, ribbed in the manner of the big 200-inch disk. This reduces its weight to only 5600 pounds, while the moving parts of the telescope weigh 45 tons. The mounting is unusual, the counterweight being offset and placed near the northern pier, in order, it is said, to avoid interference with the hydraulic hoists which operate the two platforms for the Cassegrainian arrangement. Note the ruggedness of this huge mounting, comparing its parts with the man standing in front of the northern pier. The declination bearing is especially large. The focal length is 312 inches, and the makers of the mounting figured the mirror. The design is said to be that of E. P. Burrell of Warner and Swasey

Baade, from the number of faint and previously unknown planets found on Mt. Wilson plates, estimates that the whole number observable with great telescopes is of the order of 30,000.

The total amount of labor which has already been expended upon the known asteroids is staggering to contemplate. Probably the heaviest part of this is concealed behind the single statement that 322 planets had been discovered by visual observation before 1893.

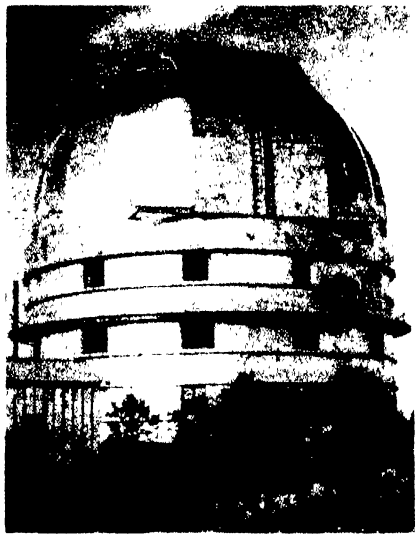
The first discovery of all—that of Ceres by Piazzi on the first night of the 19th Century, was one of those happy accidents to which the world owes so much. Piazzi, in preparing an extensive catalogue of telescopic stars, was searching for a star listed in an earlier publication as "Mayer 87"—that is, No. 87 in Mayer's Catalogue. There was no star in this catalogue in the position given; and while searching the sky to find out what was wrong, Piazzi found a moving, star-like object which, upon further observation, turned out to be a new planet in the gap between Mars and Jupiter. The original puzzle was later solved by finding that the star was No. 87 in Lacaille's Catalogue—not Mayer's—so that a slip of the compiler's pen led to the first discovery of a minor planet!

Inspired by this discovery, astronomers for a decade searched the heavens near the ecliptic, making charts of the telescopic stars, with enormous pains, and comparing them again and again with the sky, to see if anything new appeared. Three more planets were found in this way, by 1807, and nothing more for nearly 40 years. Finally, in 1845, an amateur astronomer, Hencke, who had worked for 15 years, charting fainter stars than his predecessors, found a fifth planet, and another in 1847. Since that time, every year has brought its new discoveries. Considering the very laborious method which was alone available, the discovery of 317 planets in less than half a century shows how keen were the star-gazers of a time when the astronomers' attention was less diverted than it is now into the fascinating realms of physics.

MASS-PRODUCTION in asteroid discovery came in shortly after 1890, when Max Wolf of Heidelberg applied photography. A camera, with a wide angle lens of several inches aperture, is mounted so that any desired star-field may be followed for an exposure of some hours. With careful guiding, the stars appear as small black dots on the negative. Any asteroids in the field, having moved during the exposure, appear as trails—recognizable at once.

A still more effective method was introduced later by J. H. Metcalf—an American clergyman, who designed and constructed large lenses of the highest quality as a recreation. By moving the plate slowly during the exposure, in the direction and at the rate at which an asteroid might be expected to move, the star images are drawn out into trails, while those of the planets are reduced almost to dots (not quite, because the individual planet will not move at the average rate). This concentrates the light of the asteroids, which we want, and weakens that of the stars, which we needn't bother about, and so permits the discovery of much fainter objects.

WITH these powerful methods, the rate of discovery increased so fast that it was no longer possible to keep track of all that were found. Before a fairly reliable orbit can be calculated for a planet, three good observations of its position in the heavens, at intervals of a fortnight or so, must be available. There are two serious obstacles to securing such observations—the weather and the moon. A series of successive cloudy nights may interfere with observations of a newly discovered planet until it has moved so far that the rough prediction which is possible from the direction and length of the original trail no longer suffices to find it; and too often, when the weather clears, the moon is bright and its light fogs the plate if long exposures are attempted. Even when the asteroids are the primary objects of observation, something like half of them are liable to be lost again before enough observations for a good orbit have been secured. Moreover, numerous trails of asteroids (for the most part previously unknown) are found on plates taken for other purposes, such as the search at the Lowell Observatory which resulted in the discovery of Pluto. These trails are marked on the plates for future measurement, but as they are wholly incidental to the main program, it may be years before the measures are completed and the results published.



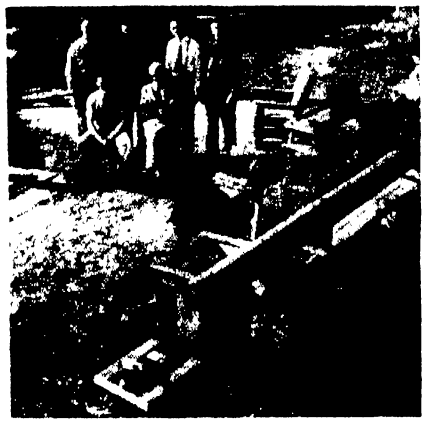
The immense dome of the McDonald Observatory, which has been built on top of Mt. Locke, in the Davis Mountains, 42 miles from Marfa, Texas, at an elevation of 7000 feet. The observatory was built by the University of Texas, and personnel for its operation will be furnished by Yerkes Observatory under the directorship of Dr. Otto Struve. The big dome is 62 feet in diameter and the cylindrical part on which it is placed is 71 feet in height. It has two separate stories beneath the rising floor of the dome, in which are the offices, library, living and sleeping quarters of the staff, also developing rooms. Every moving part of the dome and telescope may be operated from one small flexible cable in the hands of the observer, merely by pushing different buttons on a small panel

Astronomical literature, therefore, contains a steadily increasing storehouse of observations of minor planets for which orbits cannot yet be computed, but which may be utilized in future. They are, indeed, continually proving of value. When a minor planet has been well enough observed to get a trustworthy orbit, the practiced computer (like those of the Recheninstitut at Berlin) may calculate its position in the sky previous to the discovery, choosing, of course, dates when it was nearly in opposition to the sun, since this region of the sky is preferred by the asteroid-hunters. It is fairly common to find that some one of the hundreds of insufficiently observed planets was so close to the calculated position as to make identity probable. More detailed calculation will then settle this question.

The new survey lists 15 cases in which a planet turned out to have been discovered and lost again in two different years before its orbit was at last determined, and two cases in which this happened three times! Single instances are very numerous.

When at last a good enough orbit has been determined to convince the experts of the Recheninstitut (which acts as a sort of international clearing-house) that its position may be predicted for some years to come, it receives a permanent number, a place in the list, and its discoverer may give it a name.

For the first hundred planets or so, these names were taken from classical mythology or geography, but, with the present horde of aspirants, the legends of antiquity are pretty well exhausted, and a fairly wide tolerance rules, except for the convention that the names must be feminine—with the exception of certain interesting bodies which lie at the very inner edge of the great swarm, such as Eros, or at its outer fringe like the "Trojan group," which have substantially the same period as Jupiter, and have been called after Homeric heroes.



A Hale spectroheliograph and solar spectroscope, made by Samuel S. Waters of the Amateur Telescope Makers of Indianapolis, Indiana

Even the femininity of the names persists only as a matter of form—at least, such names as Chicago, Ohio, and Berkeley have been accepted for American discoveries.

A tendency to give honorary names recalling past worthies has recently been manifest: For example, asteroid number 1000 is named Piazzia, in honor of the discovery of the first; and 1001 Gaussia, in memory of the great mathematician who, faced with the unprecedented problem of calculating the orbit of a planet from observations covering only a few months, solved it so successfully that the planet (Ceres) was observed near the calculated position the following year—while the same method of calculation, with minor changes, is still in use. Not all the individuals thus honored are of a past century, nor of the Old World. Pickeringia and Frostia, for example, recall memories of friendship, as well as of scientific eminence, to many of the guild of American astronomers, while the originals of Rockefellia (901) and Hooveria (932) are not far to seek.

A NEW departure, promising an extensive addition to the list of available names, has recently appeared. Planets bear the accepted official names of Petunia, Primula, Azalea, Magnolia, Aquilegia, Lobelia, Campanula, and others of the same sort. All the members of the celestial garden have been discovered by Reinmuth of Heidelberg—whose hobby may perhaps be suspected.

When a planet has thus been provided with an orbit (that is, with one whose size, shape, and position we know), a number, and a name, one might suppose that the astronomers' work was well toward completion. In fact, all the hardest part is still to do: but the rest of the tale must wait till next month.—*Princeton University Observatory, January 5, 1936.*

In Case of War

Civilian Activities Demand Certain Essential Imports . . . War or Sanctions Would Stop Them . . . What They Are . . . Scientific Substitutes

By PHILIP H. SMITH

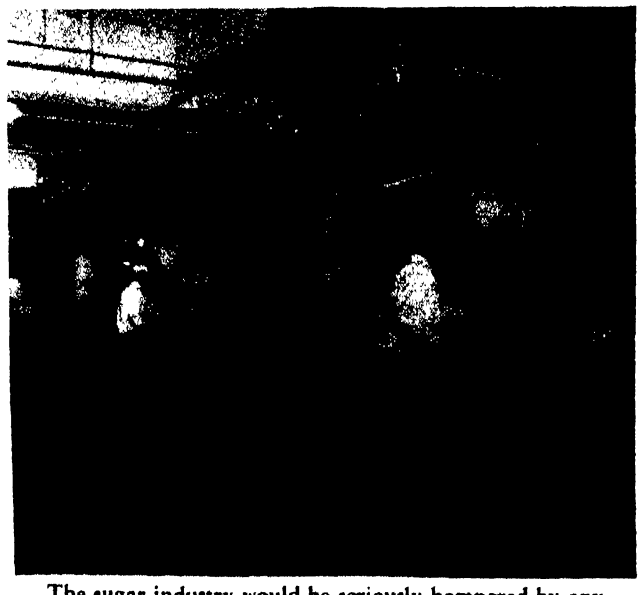
SUPPOSE the United States were cut off from the rest of the world by rigid sanctions imposed on a group of warring nations, by an isolationist neutrality act, or by a war of our own. Imagine the worst possible situation, with Canada and the countries south of us included among those to whom we could not have access. How long could we carry on civilian life? How long, if conducting a war, could we carry it on?

This supposition, improbable but not impossible, raises the question: "What materials would be war essentials for us?" We have been hearing a great deal of discussion as to what materials are and are not essentials to other nations, and the issue is not without its boomerang. It is obvious that a line drawn between materials used for war and civilian purposes is wholly imaginary. The bone and sinews of a military machine are the bone and sinews of a modern civilization. An act of war merely deflects the course a few degrees off center. At the risk of uttering a generality that glitters, it can be said that a war material, by and large, is a material essential to national life and often one which a nation does not possess as a domestic resource. The United States has its vulnerable spots—lack of domestic supplies of essential materials—and we need to know what they are and what can be done about the whole situation.

Military men ponder over this problem. It is part of their job as strategists. Based upon the above supposition, which rules out all "ifs" and "buts," our War Department states that we have just 26 tender spots—26 raw materials for which we depend upon outside sources either because we cannot produce them ourselves or, at best, cannot produce them in sufficient volume. The number is by no means large and it tends to diminish, but strategic importance is concerned much more with the question of *what* is lacking than with mere number. The "what" in this case includes eight metals, two minerals, two food products, and a miscellany of 14 vegetable and fibrous materials. Their importance ranges all the way from the vitally-needed manganese, with which most experts would top the list, to coffee, which could be replaced quite simply with cereals.

Manganese we must have for civilian as well as military use. Ferro grade manganese ore—ore having 50 percent or more manganese content—is the source of ferro-manganese which is essential to the manufacture of steel. It serves as a scavenging agent because of its affinity for oxygen and sulfur, and it imparts toughness and hardness to the finished product.

Domestic deposits of this ore are far from adequate, even for a depression-time use; commercial tonnage comes principally from Russia and, to a lesser extent, from Brazil, British India, Gold Coast, and Cuba. Our low grade ores, the ferruginous and manganiferous ores, while bountiful enough to provide for certain types of alloy steel manufacture and the production of pig iron, could not be made to serve all our needs and no substitute has been discovered.



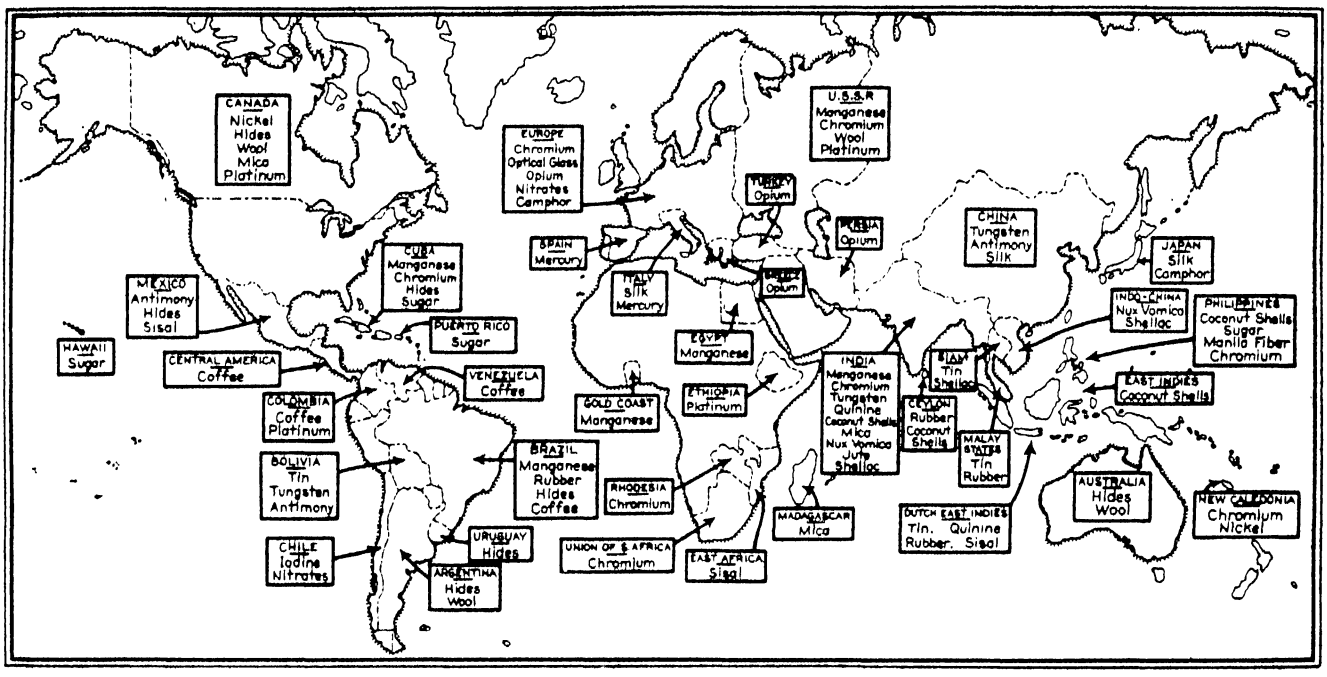
The sugar industry would be seriously hampered by any interference with imports, and the nation would suffer

STRATEGIC RAW MATERIALS	
Antimony	Nitrates
Camphor	Nux Vomica
Chromium	Opium
Cocoanut Shells	Platinum
Coffee	Quinine
Hides	Rubber
Iodine	Shellac
Jute	Silk
Manganese	Sisal
Manila Fiber	Sugar
Mercury	Tin
Mica	Tungsten
Nickel	Wool

CHROMITE ore is a close second to manganese in military and civilian importance, since chromium has come to play a large rôle in metallurgy. It is an almost indispensable alloying element in high grade steels; it has wide use in electroplating; and it is used for refractories, for pigments and for tanning certain types of leather. The United States once led the world in chromium production, but for the last 50 years imports have predominated and principal sources are now Rhodesia, Cuba, New Caledonia, Greece, and the practically unexploited Philippine ores.

The chromium situation can hardly be called as critical as that of manganese. We possess small deposits of high grade ore and considerable holdings of low grade. And, thanks to comparatively recent research, substitution has already gone forward. In certain high grade steels, molybdenum is being used instead of chromium, either straight or in conjunction with nickel; and since supplies of molybdenum are probably inexhaustible we can expect further substitution along this line.

Under conditions of extreme emergency, present consumption of chromium could be curtailed as much as 30 percent, according to some authorities. The motoring public could forego chromium plating on its motor cars; magnesite could be used for refractories, though not as efficiently; the employ-



Sources of supply of raw materials essential to the United States

ment of chromium for dyes and tanning could be dispensed with altogether. The needed balance could be very largely met by development of domestic production from both high and low grade ores, at a price.

Much has been written about the indispensable nature of tin, which is now classed as a strategic war material, but recent developments hint that the time may come when even this unique metal can be dropped from the list. The principal uses of tin are for the plating of metal containers; as a constituent of bearing metal, solder, and bronze; for tin plate, tin foil, collapsible tubes, and tin foil condensers. We have no domestic tin and must get it from the Malay States, Bolivia, Dutch East Indies, Siam, or China.

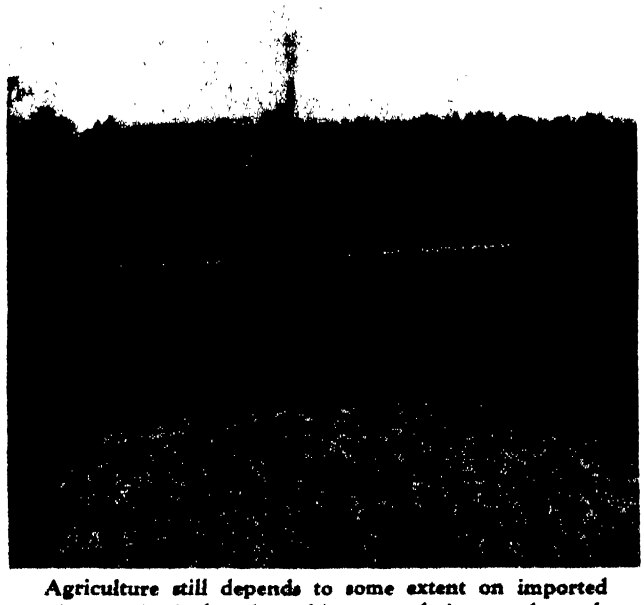
Today there are few, if any, uses for tin which cannot be handled by substitutes, and perhaps the artificial control of tin output with its resultant high price has been responsible for the search for substitutes. While tinned containers could be replaced with glass for the preservation of food, it would be at great inconvenience, and substitution is likely to be of another type. Two substitutes are on the way and give promise of success. Recently a method has been perfected for plating steel or iron with aluminum which would provide an aluminum can. Synthetic resins of the vinyl type are now being used as a coating over tin for the lining of cans and it is possible, by using this lacquer directly over the can base, to do away with tin altogether. That this has not yet been done on a commercial scale is due more to existing manufacturing set-ups and technical problems than to ultimate feasibility.

Aluminum can replace tin plate and is already being widely used for foils and collapsible tubes, and could be used for condensers. Your tooth-paste tube and the foil around the bar of chocolate you purchase are most likely made of aluminum, even now. During the past two years, research on bearing metals has brought into use cadmium-silver-copper bearings, while for solder we have lead-cadmium-zinc, and silicon in place of tin for bronze. It would be unwise, however, to bank too heavily on cadmium as a substitute for tin, because demand has already outstripped supply. Domestic cadmium is a by-product in the recovery of zinc from zinc ores and is available as yet only in relatively small amounts.

In the last analysis, tin is a convenience rather than a vital necessity and the recovery of this metal by the detinning of scrap could go far to supply needs for which there are no completely satisfactory substitutes.

TUNGSTEN, another of the strategic metals, has been of greater importance in the past than it is today, thanks to research leading to substitutes. Domestic reserves of tungsten are wholly inadequate for our needs, hence reliance upon these substitutes has become imperative. The two uses for which no replacement is at present possible are as electric contacts and as a component of tungsten carbide, that phenomenally hard substance used for dies and cutting tools. Molybdenum is now partially replacing tungsten in high speed tool steels: in the formula 18 tungsten, 4 chromium, 1 vanadium, the addition of 8 percent molybdenum reduces the tungsten to 2 percent. It is also replacing tungsten in high creep strength steels. Tungsten in armor-piercing bullet cores can be replaced with carbon steel, while its place in civilian life as filaments in electric lights can be taken over by carbon filaments, though there are many installations where vapor lamps would serve infinitely better.

Indicative of the improved strategic position is the fact that tungsten consumption has not risen proportionately with industrial expansion. This is attributable to more economical use and to efficiency in sec-



Agriculture still depends to some extent on imported nitrates. Agricultural machinery needs imported metals

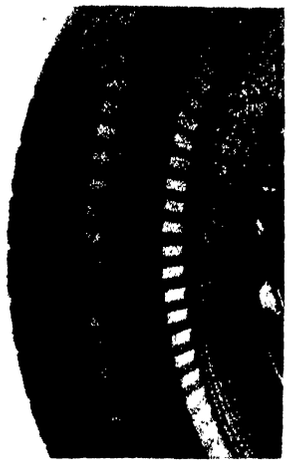
ondary recovery of the valuable metal.

Nickel occupies a unique position among the metals. It is the most widely used of alloying metals and is almost indispensable in war materials manufacture, but available stocks and the opportunities for curtailing use, coupled with the fact that the source of nickel is almost wholly concentrated just over the border in Canada, minimizes concern over supply. Nickel is still an important element in the nickel-chromium-molybdenum steels, but in certain steels molybdenum can completely replace nickel. There is no substitute for nickel as the dominant element in Monel metal, but the use of Monel metal itself could be curtailed.

ELECTROPLATING could be virtually eliminated as a consumer of nickel, if necessary. If corrosion resistance is sought, cadmium can be used, but since supplies of this substitute are not large, it is likely that there would be a return to the use of zinc. Even now the scant supply of cadmium is forcing a move in that direction. One source of nickel to be counted upon is our coinage. Although our nickel piece contains only 25 percent pure nickel, its recall would yield more than 1500 tons of the metal. Were we, in times of peace, to follow the practice of some European nations and issue coinage of pure nickel, reserves might be increased by many thousand tons.

Of the three remaining metals, antimony, mercury, and platinum, antimony may be said to figure most critically. The situation is, however, greatly relieved by a peculiarity which is regarded as unfortunate in peace time by those who like to see consumption mount. It is that a major proportion of antimony which goes into commercial channels is recovered.

The principal uses for antimony are the strictly military ones of hardening the lead in shrapnel bullets, of making a dense smoke in explosives and in making the priming mixtures for cartridges. In the first mentioned use, there can be substituted Frary metal—a composition of lead, calcium, and barium. The recoverable uses are the civilian ones where antimony is used in type metal and bearing metals and to harden the lead in battery plates. Military authorities now claim that all emergencies can be met by curtailing consumption in non-essential fields, by using substitutes, and by speeding up secondary recovery.



Transportation needs quantities of rubber

Some mercury is produced in the United States, though supplies are obtained chiefly from Spain and Italy. If we were to have such high prices as would stimulate "uneconomic" production, and if we employed all possible substitution, there is every possibility that we would survive the scarcity of this metal. Mercury is used in the fulminates of explosives, but non-mercurial substitutes are available. It is also widely used in drugs, and, while substitutes are few, a sharp curtailment could be withstood.

Platinum, which is obtained principally from Russia, is listed as a strategic material although there are broad possibilities of substitution. For example: platinized silica-gel will cut the use of platinum as a catalyzer in the manufacture of sulfuric acid; tungsten, palladium, and silver are being used for electrical contacts; stainless steel, chromium, quartz, and many other things will serve for practically all laboratory ware; that leaves precision instruments as the only item requiring platinum. Considering the vast amount of platinum jewelry adorning civilians of the nation, all vital needs could be met by a call to patriotism.

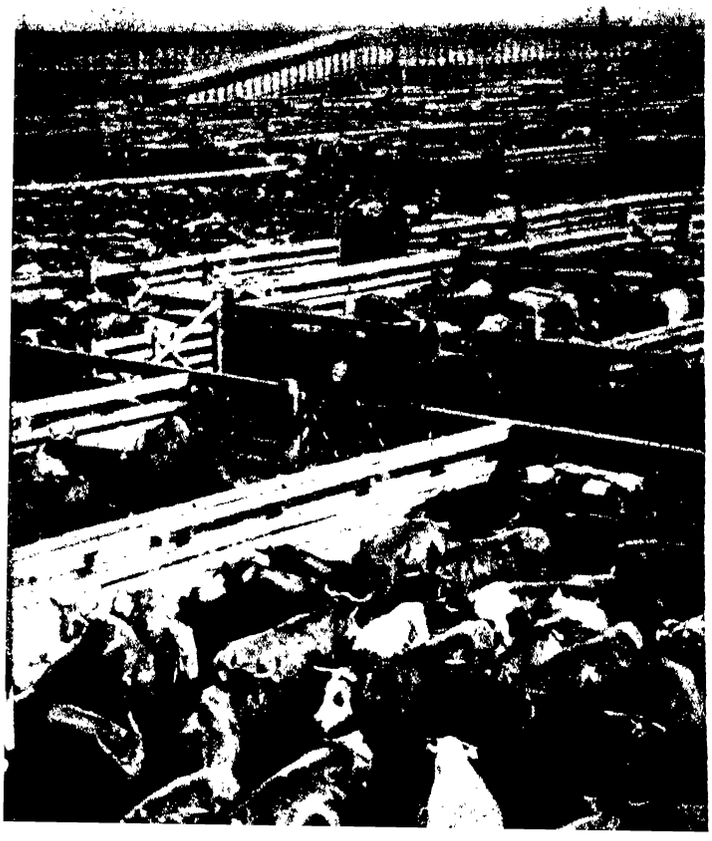
Military conflict would make scrap metal a more widely appreciated natural resource. We have all read reports of heavy purchasing of scrap by foreign powers, of the melting down of metal ships, and of the struggle to collect old machinery. However, our interest here is in scrap as a means to conserve and bring into use again strategic metal alloys, rather than as a source of iron and steel, though that, too, is important because it conserves power. Manganese cannot be recovered nor our requirements reduced by remelting scrap metal, but nickel can be salvaged and so can a certain amount of the chromium content of some alloys. Tin, tungsten, nickel, and antimony already figure importantly in secondary recovery. Presumably an already well-organized scrap metal industry could co-operate to supply even more highly selected alloyed scrap for military needs if there were occasion for it. But the steel industry would have to make further progress in the use of scrap before this source would suffice.

What other materials are vital to our war needs? The two minerals are mica and nitrates. Of small flake mica we have plenty, and our concern is with the sheet form. Given time to develop domestic resources and, meanwhile, substituting porcelain and glass wherever possible, all needs for mica as an insulating material could be met.

THERE is no question about the essential character of nitrates from which nitric acid, explosives, and fertilizer are made. There are no substitutes, but there is every indication that we now have the power and equipment to produce all the nitrates necessary. If we lacked the facilities for production, this particular item would have to be put at the head of the list, but the production impetus given by the World War has carried us beyond any critical period.

The miscellany which comprises the remainder of the War Department's classification of raw materials can be dismissed briefly, with few exceptions. We should have silk for parachutes; but powder bags, cable coverings, and clothing could be taken care of with cotton or rayon. Manila fiber could be replaced by hemp and cotton for cordage, and by wire and cotton for rope. Jute, which

ides play a very important rôle in normal American life, and eat quantities of them are imported. See map on preceding page



goes into burlap and floor covering bases, would yield to cotton; while hemp, cotton, flax, and paper could replace sisal in cordage. Wool and hides we produce in huge volume, but civilians might have to scrimp in time of war. For both these products there is a vast array of substitutes, cotton and artificial leather being the most obvious.

The situation with rubber is quite another matter. The British Empire controls 87 percent of the world's supply and we normally consume about 80 percent. Here is a raw material of vital importance both to armies and civilians, for both are now motorized to a degree where sharp curtailment in supplies would cause a serious dislocation of all activities. The bulk of rubber imports comes from the Malay States, Dutch East Indies, and Ceylon, the countries of the western hemisphere accounting for less than 2 percent. This permits easy stoppage of imports.

Platinum, which must be imported, finds use not only in the laboratory but in industry

HOWEVER, the worst has been said. The possibilities are that rubber will become less of a problem as time goes on. Chemists have been extremely successful in developing synthetic rubbers so that, in time, military needs might be met with substitutes. Duprene, Thiokol, and Koroseal are laboratory products gradually entering into commerce. High production cost, which stands in the way of their exploitation, is a problem which is slowly being solved, and cost is not the primary factor in wartime. Hope is expressed that rubber can be obtained from domestic products, Edison's goldenrod-rubber experiments showing the way.

Wool is an essential commodity of which this country has but little

Two more possibilities contribute toward making the rubber war-time picture more optimistic. Reclamation of scrap rubber now accounts for about one third of the total rubber consumed annually in this country, and this could be stepped up considerably in an emergency. Retreading of old tires affords the second important opportunity.

Research has also brought relief for three other products listed as strategic. Iodine, used for drugs, dyes, and photography, comes mainly from Chile, but recovery from oil well brines is being carried out successfully in California and all needs can thus be met. Camphor is being made synthetically from turpentine; and shellac, which normally goes into paints, varnishes, plastics, and binders, can be replaced by nitrocellulose lacquers and synthetic resins.

The two strategic foods can be managed with a fair degree of ease. Sugar supplies can be augmented by corn, grape, and maple sugars and by saccharine; coffee can be replaced by cereals as it was in Germany during the World War. This leaves four raw materials for which no substitutes are available. They are quinine, nux vomica, opium, and cocoanut shells, this last used in the manufacture of activated carbon for gas masks.

We should recall here that the foregoing list of raw materials is compiled on an assumption of complete stoppage of trade. This is, of course, hardly probable. If we assume an alignment of nations, the picture immediately changes and changes with every grouping one can conceive. Should trade routes to our southern neighbors remain open, for example, the war situation would be immensely simplified, as can be seen by reference to the source map.

Successful procurement of raw materials depends upon many things. Immediate sequestration of existing stocks would be the first step, then regulation of use. Control which would cut off unnecessary consumption would solve any problem relating to wool, hides, opium, quinine, sugar, and coffee. Certain of the materials—notably manganese, chromium, nickel, tungsten, tin, and rubber—are held in storage in considerable volume against later commercial use. These stocks could be sequestered. Nickel and platinum stocks could be augmented by calling in currency and jewelry, respectively.

PERSONS at all familiar with the raw materials problem must be struck with the enormous advances made toward self-sufficiency since the World War. Artificial nitrates, synthetic camphor and rubber, iodine extraction, and synthetic resins are all post-war developments. The outcome may shortly be a smaller list of essentials. Chemistry has done much to free this country from dependency upon the rest of the world. The aims of chemistry may not be grounded in war conditions and many of its contributions are quite accidental (commercial supply and demand governs research more than war threats) but the fruit is rich enough to warrant a great deal of faith being placed in the laboratory.

Another possible contribution to the solution of the problem arises from the use of airplanes in mining operations. A difficulty in procuring several domestic metals has been the remoteness of deposits and the lack of transportation facilities. Now comes the airplane to offer a solution. There are today mines in Alaska which have been opened, equipped, and had ores removed from them with no other facilities than aircraft. Does this not suggest practicability in event of war?

Our own peculiar position is most strikingly brought out by this compilation of strategic products. The total absence from this list of such vitally important products as wheat, coal, oil, iron, copper, and cotton is particularly significant. It is the lack of such items which gives the war strategists of almost all other countries of the world an insoluble problem with which to wrestle. That they are no concern of the United States simply means that Nature favored us when distributing the raw materials of the earth and perhaps she did so in the interests of peace rather than war.

WHY AREN'T MORE WOMEN ATHLETES?

Exceptions . . . Muscular Development Interferes with Motherhood . . . Women Tend to Shun Competition

By DONALD A. LAIRD, Ph.D., Sci.D.
Psychological Laboratory, Hamilton, New York

IF the average woman's credit were better, women would be better athletes than they are. And thereby hangs an interesting story, as we shall see as we read on.

There have always been a few outstanding, and exceptional, women athletes—such as Helen Wills Moody, Eleanor Holm, Babe Didrikson; or 19-year-old Virne Beatrice Mitchell who received 1000 dollars a month as pitcher for the House of David baseball team; or 25-year-old Georgia Englehardt who has scaled nearly 100 of the loftiest mountains; or Marjorie Foster who defeated 99 men, all soldiers, and won the King's rifle match in England.

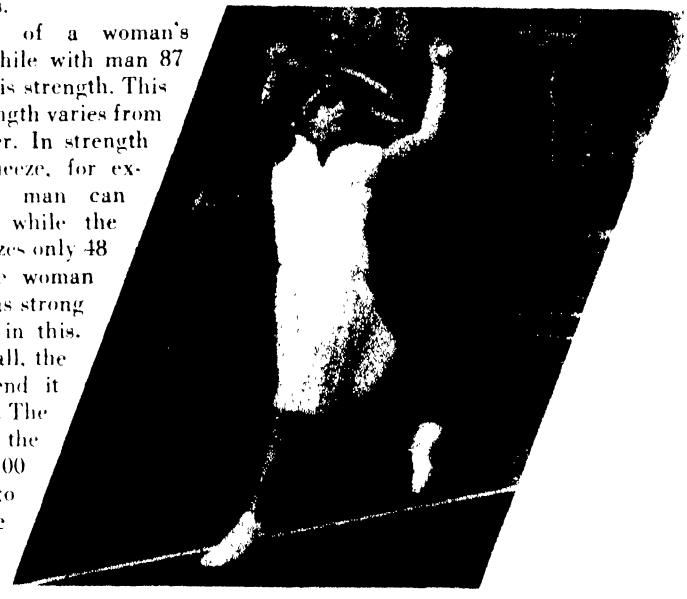
Such energetic women are exceptions to the rule, for women have many characteristics which definitely place them at a disadvantage in such so-called manly pursuits. For one thing, men are more pugnacious and self-assertive than women. As a rule women do not like open competition.

The average woman's strength also keeps her from being much of an athlete. Of course women are not as large as men, being an average of some five inches shorter. But the differences in the relative strength of the two sexes are greater than any differences in mere size. The average woman's body, for example, is slightly less than one third muscle, while the average man's is slightly more than one third muscle. Women's muscles are proportionately longer and thinner, and their muscle fibers are less viscous.

Fifty-four percent of a woman's weight is strength, while with man 87 percent of his weight is strength. This ratio of weight to strength varies from one muscle to another. In strength of grip, or hand-squeeze, for example, the average man can squeeze 81 pounds, while the average woman squeezes only 48 pounds. Scarcely one woman out of a thousand is as strong as the average man in this.

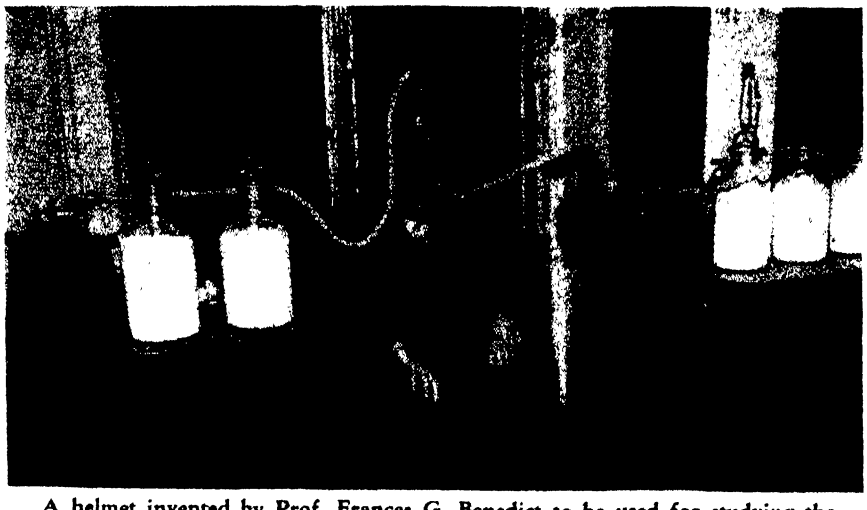
In driving a golf ball, the average man can send it from 120 to 140 yards. The average woman drives the same ball only 70 or 100 yards. When it comes to the high vault, the record for men is twice that of women. In socking the baseball out into center field, too, the men can bat it about twice as far as women. All in all, men's athletic records are about half as good again as women's. The women who swam the English Channel have shown undenied endurance, but they have not approached the average time of the many men who have swum the same channel.

Differences in muscular strength are one obvious reason for the athletic differences between the sexes. Strength, however, is only one of a number of peculiarities. The joint surfaces of women are smaller, just as their individual



muscles are relatively longer and thinner than men's, and this contributes to their lack of athletic excellence.

Although women's muscles may be able to move just as rapidly as a man's, yet women do not use them as rapidly. Something happens in woman's nervous system that slows down her reactions. Dr. L. M. Gibson has found that women show a very marked delay in their decision time. That this slowness is not due to changing their minds, but primarily to delay in reacting, is shown by a study reported in 1933 by Dr. Edwin G. Flemming, the brilliant New York City psychologist, who concluded that "women do not change their minds to a greater extent than men; in fact, the situation is, if anything, just the reverse."



A helmet invented by Prof. Frances G. Benedict to be used for studying the chemistry of breathing. Oxygen "credit" is of very great importance to athletes

In line with this is the finding made by Prof. C. E. Tucker of the Massachusetts Institute of Technology that it takes the average man 70/100 of a second to apply the brakes of his automobile after he sees the "stop" signal on the car ahead of him, but that it takes a woman 87/100 of a second to perform the same operation under the same conditions. Almost half of the women, in fact, required a full second or more to get the brake pedal down.

This delayed decision time, of course, is a disadvantage in co-operative games. The base-ball player must make a quick decision whether to throw the ball to first base or third base, whether to steal another base or stick close to the bag. In football the decisions are still more important. This, as much as any intrinsic differences in strength or endurance, is why the rules under which women play basket ball, for example, are so different from the rules for the man's game.

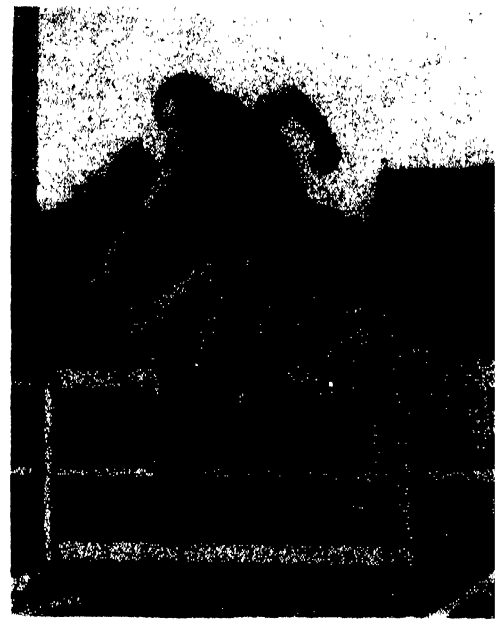
Women's bones help to make her superior in dancing, although they may make her deficient in other exercises. Not only are her joint surfaces smaller, and her elbows and knees knocked-in a bit, but the proportions of her bones are different. Her legs are short in comparison with her trunk length. That handicaps her, of course, in jumping or running, since she cannot cover as much territory in a single stride as a smaller and weaker man can.

Her relatively short legs, however, make it easy for her to bend at the waist and touch the floor with the tips of her fingers, without bending her knees. The average man's long legs keep him so high up in the air that it takes long practice for him to do this thing which almost any woman can do the first time she tries.

Men's shoulders are distinctly broader, while it is women's hips which are wider. And it is these bony differences which contain the secret of woman's relatively limited endurance. Broad shoulders indicate ample development of heart and lungs, which provide the "credit" needed for athletic work.

Dr. A. V. Hill, the distinguished English physiologist, has pointed out how muscular work is done on credit, by running up an oxygen debt. When a muscle contracts, chemical changes take place. The by-products of this change can be eliminated only by oxygen carried to the muscles by the blood. When a person engages in some strenuous activity, the by-products accumulate much faster than the regular blood oxygen supply can convert them into less-poisonous substances. The hard-working athlete actually poisons himself.

The skilled man runner, for example, will accumulate an oxygen debt of this sort in the 10 seconds of the 100 yard dash which it requires two or three hours for the blood oxygen to pay off. That is why people breathe rapidly and their hearts thump faster after some exertion. The rapid breathing gets more oxygen into the lungs and the faster flowing blood carries more of it every minute to relieve the condition of the semi-poisoned muscles—poisoned with the products of their own exertion until with time these are removed.



Exceptions to the general rule: *Above:* Mildred ("Babe") Didrikson, all-around athlete. *Left:* Georgia Coleman, swimming champion. *Opposite page:* Helen Wills Moody, tennis ace who came back

But the average woman has her greater development in stomach and other organs of her abdomen. Her lungs are not sized as generously as man's, and it is difficult for her lungs to take in enough oxygen to pay off the oxygen debt. Her blood itself would not absorb as much oxygen, even if her lungs took it in, for she has about one fourth fewer red cells, and those are the ones which carry oxygen to relieve the half-narcotized muscles.

Women athletes, soldiers, and bullfighters need not only the lung development of the average man, but also the oxygen carrying power of man's blood. Channel swimmers, such as Gertrude Ederle and the other half-dozen women who have negotiated the English Channel, have most need for these two vital things, for the long continued exertion of swimming such a distance would otherwise run up such a terrific oxygen debt that it could hardly ever be paid off.

Anthropmetric measurements indicate that women have been gradually increasing in muscular strength in recent years. Dr. Knight Dunlap, psychologist at Johns Hopkins University, reports that "it is interesting to note that year by year, as girls and young women go in more and more for athletics, sports, and outdoor life, the track, field, and strength test records for women approach nearer and nearer to those for men. Laboratory records will probably show that the resistance to fatigue of these hardier women approaches male standards."

It may be a good thing, however, that women are not as a general rule interested in athletic things and the development of more powerful muscles, for it has been noted by many scientific observers that feminine muscular development interferes with motherhood. What woman needs—and has—is a good system of involuntary muscles, not bulging biceps or the hand-squeeze of a sailor. She has plenty of muscle and oxygen carrying power for simple household tasks which take plenty of oxygen. She has ample development for a multitude of light office and factory work. But men should keep her away from the heavier tasks, both out of chivalry and good sense. She can stand loss of food and deprivation of sleep better than can men, and has greater resistance to many diseases. But measured by strength or any athletic endeavors, she justly belongs to the weaker sex. Hardier perhaps, but at the same time undeniably weaker.

"Women have more strength in their looks than we have in our laws," wrote Saville, "more power by their tears than we have by our arguments." Which consideration makes the odds about even again.

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Conducted by F. D. McHUGH

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Laboratory Earthquakes

A NEW type of shaking table has been built at the Massachusetts Institute of Technology for studying the destructive effects of earthquakes on buildings and other engineering structures. This machine makes it possible for the first time to duplicate in the laboratory the motions of destructive earthquakes directly from seismograph records.

The laboratory earthquake equipment set up to test a model tank

In the foreground of our illustration, Arthur C. Ruge, research associate in the Department of Civil Engineering, who designed the machine, is adjusting the optical system and electrical "thinking" device, which has an electric eye that follows the wavy outline of the shadowgraph of an earthquake record. The white shadowgraph in front of him is a seismograph record of the Long Beach, California, earthquake of 1933. A pencil of light is the only connection between this device and the shaking table on which the scale model of an elevated water tank is being tested.

Beyond the model is the driving mechanism, including an oil-actuated piston which moves the table under the control of a very sensitive, quick-acting valve which transmits to the piston every detail of the earthquake waves as they are seen on the shadowgraph by the electric eye. The model of the water tank under test is five feet high and holds 10 pounds of water. The new machine makes it possible to see just what might have happened to a full-size structure of like design in the Long Beach earthquake.

PETROLEUM RESERVES

ACCORDING to the American Petroleum Institute, proved underground reserves of petroleum in known fields of the United States are 12,177,000,000 barrels. This does not include an indeterminate quantity left in the ground by present producing methods, but possibly recoverable by advanced methods of production.

The Sugar Cane Doctor

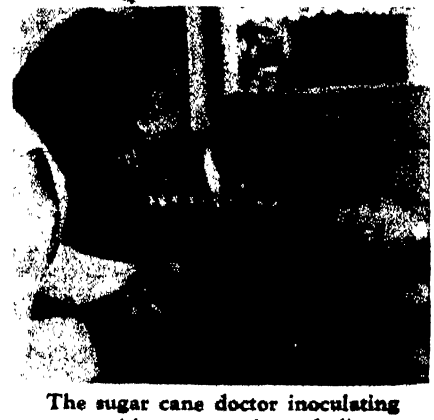
"HERE in Hawaii," says J. P. Martin, Pathologist, Experiment Station, Hawaiian Sugar Planters' Association, Honolulu, "the two major problems facing the American sugar industry are diseases and insects. However, these are problems of major importance in all sugar producing regions, and must be considered by the scientists in order to obtain the maximum yield per acre.

"The sugar cane plant, like other economic agricultural plants, is frequently affected by diseases which cause large financial losses to the grower. The duty of the phytopathologist, or 'cane doctor,' is to determine ways and means for controlling these diseases.

"In general, diseases affecting the sugar cane plant may be classified into three groups, namely: (1) non-parasitic diseases—wherein the depressed growth of the plant is directly associated with poor chemical or physical soil conditions or adverse climatic conditions; (2) parasitic diseases—wherein the subnormal growth of the plant is caused by specific organisms known as fungi or bacteria which live at the expense of the cane plant once they have become established within the plant; (3) virus diseases—wherein the failure of normal plant growth is caused by ultra-microscopic entities or bodies of an unknown nature found within the plant that are capable of producing disease. Insects play an important rôle in this group since they act as carriers of the virus and incidentally inoculate healthy plants during their search for food.

"It is not always a simple matter to bring about a satisfactory control of a disease once it has become established in a cane field. The outstanding control of any sugar cane disease has been accomplished by the use of resistant varieties. A variety may be highly resistant to a specific disease but be of little commercial value because of its poor sugar-producing qualities. The ideal variety, namely, the one possessing both disease-resistance and high sucrose qualities, is obtained only after many trials which must extend over several crop periods, each crop period being approximately 18 months in length.

"The degree of resistance or susceptibility of a variety to certain diseases may be determined by inoculating the plant with a pure culture of the causal organism of that particular disease. It is often possible to isolate from diseased cane tissues the fungus or bacterium which is responsible for causing the disease. It is also possible to grow the organism on an artificial medium and maintain it in a pure culture without the aid of the cane plant. When cane plants are



The sugar cane doctor inoculating cane with an organism of disease

to be tested against a disease, the organism is then taken from a pure culture and injected into the cane plant, frequently by the hypodermic needle method or, as in the case of eye spot disease, by spraying spores of the eye spot fungus on the leaves of the plants to be tested.

"The inoculation tests are conducted under field conditions most suitable for the development of the disease and, after a stated interval, the degree of resistance of each variety is determined. In such a test, anywhere from 100 to 200 of the more promising agricultural varieties are included."

Methyl Bromide Fire Extinguisher

METHYL bromide is recommended as a fire extinguisher for certain types of fires instead of carbon tetrachloride, according to *Chemical Age*, which reports that methyl bromide produces 1.6 times as much gas as carbon "tet" and is six times as effective. Boiling at 4.5 degrees, Centigrade, methyl bromide volatilizes very rapidly when thrown on a fire. Neither this fact, nor the large volume of gas liberated is sufficient to explain the effectiveness of methyl bromide as a fire extinguisher, however. It is believed that the presence of bromine in the gas has a definite inhibiting effect on combustion. *A. E. B.*

American Influence on Early European Railroad Building

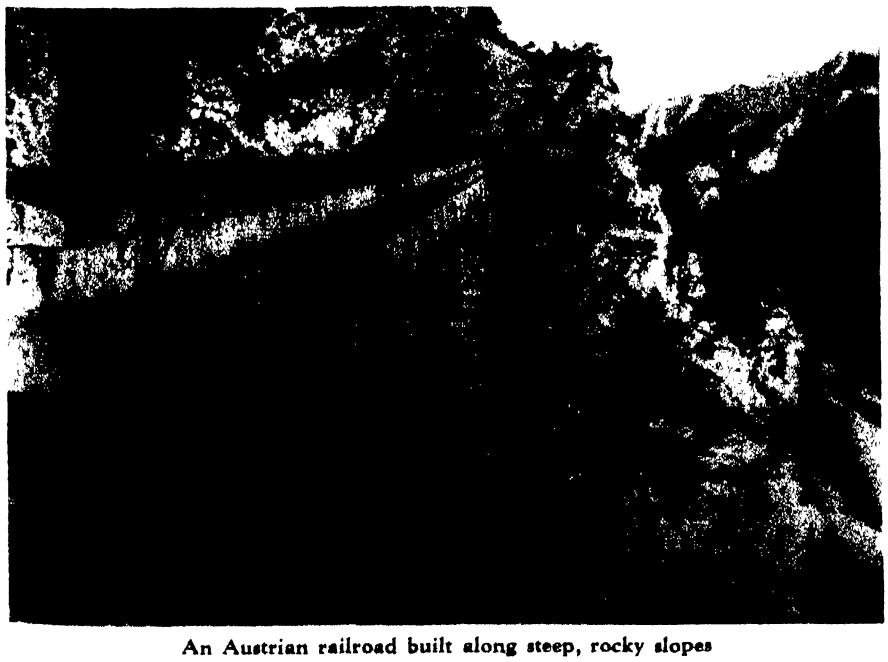
THE accompanying photographs show sections of the famous Austrian railroad from Vienna south over the Semmering Mountains which is credited with being the first large mountain railroad. An interesting story lies behind the construction of this road, according to an old volume which has just come to light.

Back in 1829, consideration was given to the possibility of connecting Vienna with the Adriatic Sea at Trieste, and with the coal fields of the north, in Silesia. At that time no European engineers had had experience in mountain railroading and their opinion was that the British scheme of road building would have to be followed. Its ideal was to have a track of no sharper curves than three and one half degrees, and grades of not more than 0.5 percent. Due to the steepness of the grades on the proposed route, the pulling of cars over inclines by means of rope operated by stationary steam engines was the solution generally accepted.

Entering the Semmering Mountains on the Austrian Southern Railroad

There was a wide difference of opinion in Austria and the Austrian engineer von Schoenerer finally came to America and carried back with him the confirmation that America had emancipated itself from British tradition; he asserted that a locomotive road over the Semmering would be the correct solution. In spite of his complete report of the manner in which American engineers had conquered difficulties of terrain and his statement that the road could be built without the use of rope-operated sections, the fight went on until the government stepped in and ordered the road built, and sent the engineer von Ghega to America to report fully. He inspected the Baltimore & Ohio road which had then progressed to Harper's Ferry. The road was accordingly built.

So well did Ghega's observations serve his purpose that, coördinating them with his own genius, his solution for the Semmering Railroad, for which he chose two and one half percent grades and nine and one half degree curves, became the model mountain railroad of Europe, in addition to being the first enterprise of its size and difficulty in the world, and one of the most beautiful and successful.



An Austrian railroad built along steep, rocky slopes

TROJAN WAR

PRIAM fought on layer seven. This may sound somewhat cryptic but it means simply that recent excavations have indicated that the Homeric city was the seventh layer in the mound which constitutes the ruins of the nine cities built upon the site of Troy.

Codling Moth Control

PHENOTHIAZINE, a compound prepared by fusing sulfur with diphenylamine, has been mentioned in these columns for its remarkable toxicity to mosquito larvae. Lately it has shown promise for killing young codling moth larvae, when sprayed on apple trees. Some laboratory and field tests have given promising results but further tests are needed. These studies are being made in order to find a substitute for lead arsenate, which still remains the most generally used material.—*A. E. B.*

Pimples

ACNE is associated with abnormality of the sex hormone, according to Dr. Theodore Rosenthal of the dermatology department of the Columbia University School of Medicine.

"The evidence is strong," he said, "that acne is caused by disturbance in the sex endocrines. Just what the disturbance is, or how it acts, is not clear. Endocrine therapy for acne is not yet reliable because we do not know the best preparations to use, or how best to administer them. Chocolate, white bread, and iodized salt are three foods which have been found to create digestive disturbances aggravating this common skin disease of adolescence," he declares.

"It is a clinical observation that choco-

late in any form may produce new outbreaks, or aggravate existing acne lesions in some individuals," Dr. Rosenthal said. "White bread, particularly in large cities, contains potassium bromate introduced as a riser, which in baking is reduced to the bromide. This of course must be eliminated.

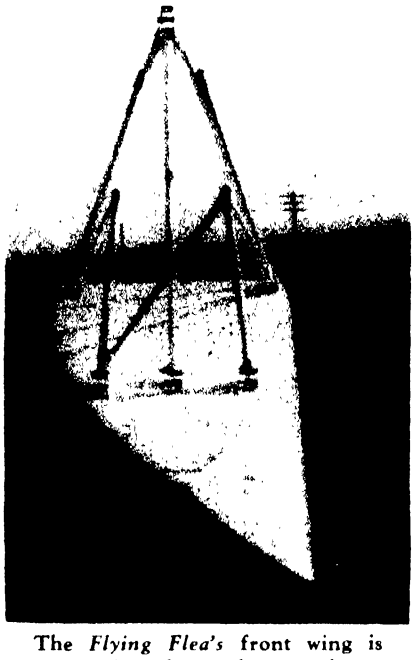
"At the same time a careful search for iodides and bromides in food or incidental medication must be made. The most frequent offender is iodized salt."

Correction of personal food fads, bringing the weight up or down to normal, rest, exercise, fresh air, and sunlight are also imperative in the treatment of the disease, he adds.

Because few children are entirely free from facial eruptions, Dr. Rosenthal points out that a few acne lesions at the age of puberty are physiologically normal. "It is only when the lesions are unusually numerous, severe, or persistent that we can consider it as a disease."

The "Flying Flea"

THE *Pou de Ciel*, built by a French furniture manufacturer, M. Henri Mignet, and illustrated here, has created quite a sensation in France and England. More than 150 of these tiny machines are flying

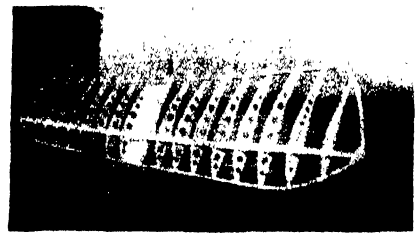


The *Flying Flea's* front wing is mounted on the top bearing shown

in these two countries. Many of them have been built by amateurs following the instructions in M. Mignet's book, and without special shop or tool facilities. Building the *Flying Flea* at home is both simple and inexpensive, and even when factory built the sales price in England is only about 800 dollars. The *Flying Flea* has now been brought to this country by Major Sidney Arram, and has been flying at Roosevelt Field, Long Island.

The question that now arises is: Is this the long expected "flivver" airplane that is going to make private flying possible to everyone?

The *Pou de Ciel* has one large wing above, and a smaller lower wing immediately behind the upper one. The total wing area is



Simple yet strong construction of the main wing of the *Flying Flea*

132 square feet. The gross weight is about 650 pounds. Total span is 19.9 feet and the over-all length is 11.1 feet. With a 20 horsepower, two-cylinder, two-cycle engine, a "fast" cruising speed of 62 miles per hour is claimed; take-off and landing can be accomplished in short distances.

A personal inspection of the small aircraft at Roosevelt Field gave us the following impressions: When seen in a hangar, by the side of the conventional three-seater cabin plane, the *Pou de Ciel* certainly looks tiny. It is pleasing to be able to raise the tail and move the machine about, unaided. Certainly this makes for very easy handling by the owner. The construction and appearance of the machine are apt to suffer by comparison with conventional modern aircraft, but they will pass muster. The construction is indeed very simple, and, while the cockpit is a little cramped for a large man, it probably is ample for the average youngster. The vision ahead is perfect. It would be rather amusing to fly in the somewhat drafty cockpit and again experience the thrill of open cockpit flying of the early days. The installation of the power plant is simplicity itself so that keeping engine and plane going would be just as easy a task as building the plane in the first place.

Now we must consider the heart of the question, which lies in the aerodynamics and flying characteristics of the craft.

There is no elevator. The front wing is hinged at a point forward of its quarter-chord point, and its center of pressure is constant and ahead of the center of gravity. From the upper wing two wires run down to the control stick. Since the center of pressure of the wing is behind the hinge, it is always tending to rise and push the stick forward. When the pilot pulls back on the stick, the wires tighten and the front wing is pulled down to a higher angle of attack. It then lifts more than before and the nose of the machine rises. To secure change in speed it is not necessary to change the whole attitude of the machine as much as in the conventional airplane. The longitudinal control is very good. Again, the front wing is in the upwash of the rear wing and stalls first. Hence there is little danger of the

FORTY PLANE CAPACITY

FORTY "Cubs"—a popular two-place sport plane, made by Taylor in Bradford, Pennsylvania—could be carried in the *China Clipper* if they could be packed in the space available.

"stalling" of the craft as a whole; this is a decided advantage.

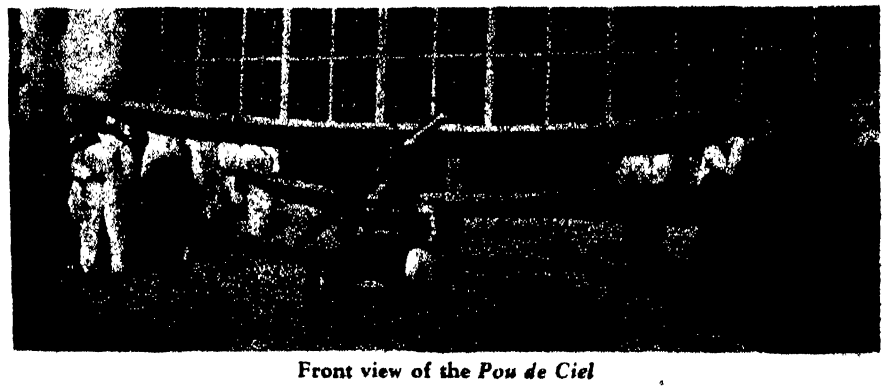
With a large rudder and powerful dihedral, ailerons are dispensed with. In making a turn to the right, the plane skids to the left under the action of centrifugal force, and then the dihedral banks the plane automatically for the turn. It should be noted that the stick controls both the change of incidence of the front wing and the rudder, so that the conventional rudder bar is eliminated and the novice does not have to

Prof. Klemin finds rather cramped quarters in the cockpit of the *Flea*

learn the difficult art of coördinating the action of hands and feet.

Here is the balance sheet: On the good side—something very inexpensive to build and maintain; very handy; fairly easy to learn to fly, with one control eliminated; moderate speed but good landing and take-off characteristics. Probably a quite satisfactory craft for fair weather flying just around the aerodrome.

On the bad side—not enough speed for



Front view of the *Pou de Ciel*

cross-country work; a simple but not a positive control system—neither turns nor corrections against a roll will be clean or assured: anyone who learns to fly on this ship will have to start afresh on a conventional machine; anyone who learns to fly in a conventional airplane will have to learn over again when handling the *Flea*.

On the whole, it would seem as if the contribution of the *Pou de Ciel* to the advancement of real private flying will be very small. But it should provide a fascinating, inexpensive hobby for young men or even boys, who just want to fly around at minimum expense, and from this point of view we wish it all success.—*A. K.*

Douglas Sleepers

A NUMBER of new Douglas sleeper airplanes, models DST, are being placed in service by American Airlines. The DST is essentially a development of the famous Douglas DC-2, of the same general type and construction but of larger size and increased horsepower and weight. The wing span has been increased to 95 feet. To accommodate the sleeper berths the fuselage has been increased slightly in depth and is approximately two feet wider. The over-all length is now 65 feet and the over-all height is 17½ feet.

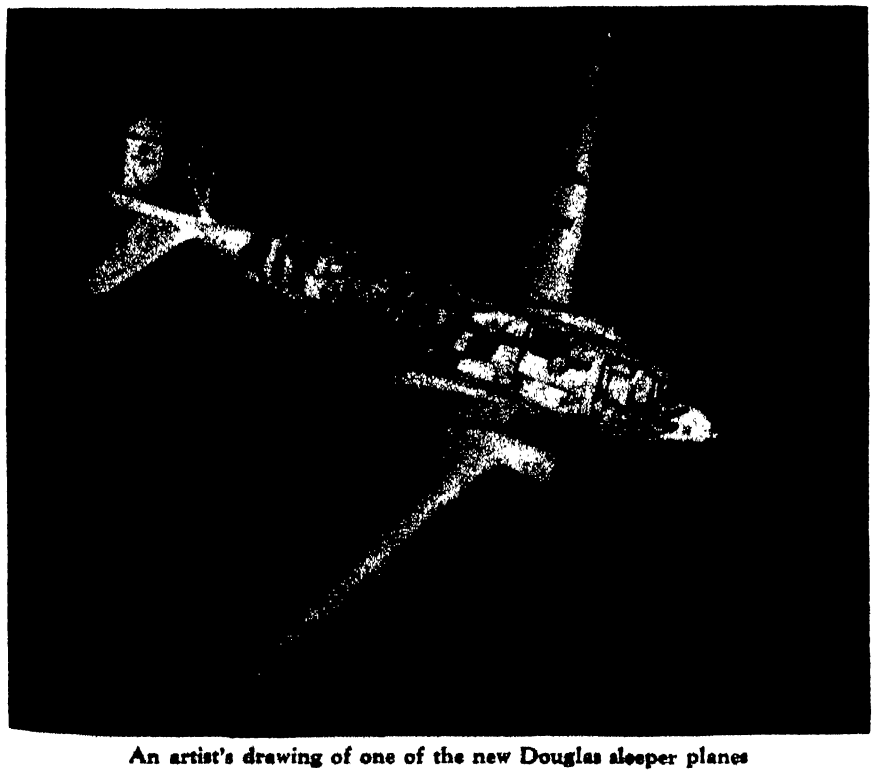
The weight empty is 16,000 pounds; the weight fully loaded is 24,000 pounds, leaving a useful load of about 8000 pounds.

The fuel capacity is 825 gallons, and the oil capacity 66 gallons. Fuel is carried in four tanks of approximately 200 gallons each. The Wright Cyclone G-5 engines use Hamilton Standard, constant-speed, controllable-pitch propellers. Sperry Automatic Pilot, heating equipment for carbureter de-icing, and emergency alcohol de-icing equipment for windshield and propellers will be among the modern equipment carried. Complete two-way radio, ultra-violet instrument lighting, and improved steam heating will also be provided.

The cabin accommodations are arranged for 16 sleeper-passengers with a possible maximum of 32 day-passengers for short hauls. The berth arrangement is essentially Pullman type, the seats and berths being 36 inches wide. Double dressing rooms and lavatory facilities are provided at the rear of the cabin. Mail will be carried forward of the passenger accommodations and baggage and express aft. Facilities for handling meals are provided in the form of individual tables for each compartment and a completely equipped buffet forward of the main cabin. The airplane crew will consist of pilot, co-pilot, and stewardess.

The high speed at rated power and altitude of 11,000 feet is computed to be 219 miles per hour.

It is hardly necessary to emphasize how complete and adequate such an airplane really is for passenger transport.—*A. K.*



An artist's drawing of one of the new Douglas sleeper planes

Radio Meteorography

AVIATION weather service has made notable advances in the development of radio meteorography. The aeronautical meteorologist needs daily and even hourly cross-sections of the atmosphere with regard to its pressure, temperature, humidity, wind direction, and velocity up to great heights. With information of this kind available for all levels, up to and including the stratosphere, the method of forecasting by studying "air mass" movements becomes truly effective.

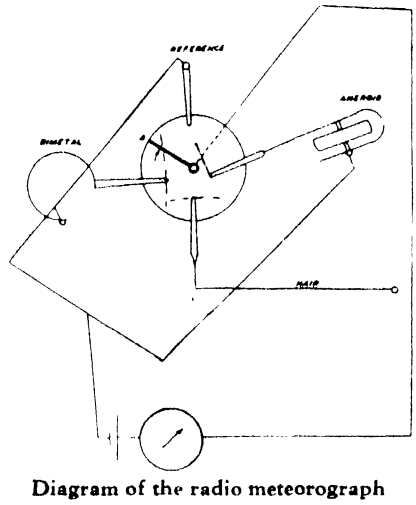


Diagram of the radio meteorograph

***Above:* Compact short-wave transmitter for the radio meteorograph. *Below:* In its streamlined housing**

Upper-air data have hitherto been obtained by pilot balloons, airplanes, sounding balloons, mountain stations, and the observation of clouds. Serious objections can be raised to all of these.

The ideal method of observation is the sounding balloon equipped for radio transmission, so that there is no limitation as to height and so that information is instantly transmitted to the weather station; in other words, a sounding balloon provided with a "radio meteorograph."

Such instruments have already been used in airplanes, but the final development for use in sounding balloons has only recently been completed at the Blue Hill Observatory in Massachusetts, under the direction of Dr. Charles F. Brooks.

The principle of the meteorograph is quite simple and is illustrated diagrammatically in our drawing.

A rotor A turns around a center at constant speed—say once every 30 seconds—and at each revolution makes contact through the point marked "Reference" in the diagram. Three instruments are carried aloft: an aneroid barometer or pressure indicator of conventional principle; a hygrometer, consisting of a hair which expands and contracts as the humidity changes; and a thin bimetal thermometer. Each of these instruments moves a small extension-arm which has a very fine point at its end. The rotor is insulated everywhere except for three metal spirals embedded smoothly in its sides. The extension arms make contact with these spirals, the duration of contact depending on the positions of the extension arms; these positions depend on the readings of the aneroid, the thermometer, and the hygrometer.

Once an electrical contact of varying duration is made, it is obvious that a radio transmitter can be put into operation and a complete record transmitted directly to the ground.

The great problem is to keep the weight

of the instruments and transmitter on the sounding balloon down to a minimum, so as to permit a rapid rate of ascent. Such a rate is indispensable so that the ground distance between transmitter and receiver does not become too great and also to provide a more useful meteorological record.

The weight of the radio equipment and the meteorograph has been kept down to a little over two pounds by very refined design of the meteorograph and by the use of short waves.

Up to 20,000 feet a wavelength of 5 meters has proved satisfactory. A tiny 4½ volt battery allows three or four hours of operation, and weighs only 150 grams. A conventional two tube oscillator circuit is employed.

The meteorograph and the radio transmitter are all mounted within a bullet-like shell (so designed to reduce air resistance in the climb), which is suspended below the sounding balloon.

Reception of the ultra-short waves may be aural or on a recording chronograph which is synchronized with the turning of the rotor on the meteorograph. Great credit is due to the meteorologists, radio, and instrument experts who have collaborated in producing this useful device.—*A. K.*

Brakes for Airplanes

WHEN making a normal landing, the airplane pilot closes the throttle but the propeller continues to turn like a windmill, retarding and disturbing the air flow behind it. If the propeller is disposed ahead of the wing, it spoils the lift over that portion of the wing which its disk area embraces. The landing speed goes up accordingly, which is undesirable.

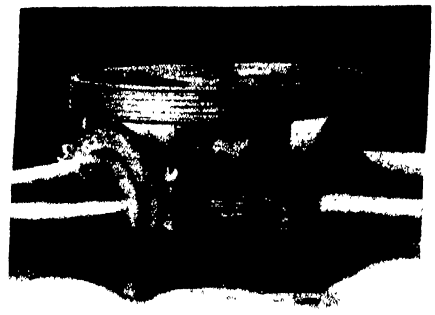
In a multi-engined airplane with several propellers ahead of the wing, there are other unpleasant effects. If an outboard engine quits, the loss of lift means that, in addition to the rudder, ailerons have to be used to counteract the rolling moment due

Brake bands on engine nose

to unequal lift over the two sides of the wing. Thus a double task is imposed on the pilot. Also, the drag of the idling propeller is considerable and that means more rudder than with a stationary airscrew. An idling propeller also introduces unpleasant vibrations.

From every point of view, therefore, it would seem desirable that as soon as an engine stops either voluntarily or involuntarily, the propeller should be prevented from windmilling.

Many attempts have been made to provide brakes for stopping the airscrew simultaneously with the engine, but none of these brakes have been sufficiently simple,



Brake drum on propeller hub

inexpensive and light enough to warrant their general use.

Now we learn that Raymond B. Quick has given the problem intensive study and in collaboration with the engineers of Sikorsky Aircraft Corporation has produced an entirely practical device which has been used with much success on the Sikorsky Clipper, the *S-42*. The entire brake installation weighs only 52 pounds, and is extremely simple, being operated by an oil pressure system similar to that used in "hydraulic" brakes on automobiles.

The brake shoes which act on a drum are hinged on the nose section. The shoes are made of duralumin castings. The brake drum is machined from a steel forging and has cooling fins. It is connected to six hub bolts on the three bladed propeller by means of welded fittings.—*A. K.*

New Swedish Radio Beacon

A SWEDISH radio beacon of a new type has been delivered to the Turkish government and erected at Rumeli, a small fishing village on the coast of the Black Sea. It stands on a rock, and sends directed radio beams, so that approaching ships need use only ordinary radio receivers. The position of the vessel in relation to the beacon is determined by counting the number of signals received, after the call signal, until the sound completely disappears. The number of signals heard corresponds to the number of degrees from the west over the beacon to the vessel. To facilitate the counting, every tenth-degree signal is of a lower tone than the rest. Therefore, it is only necessary to count the signals in groups of 10, and when the sound becomes fainter to begin to count the degree signals.

Like the radio-sounding receiving sets, the beacon is equipped with a loop antenna. To correspond with the antennas on the ships, the beacon antenna should revolve according to the signals dispatched, but it would entail great technical difficulties to rotate the large frame in time with the signals. Therefore, a goniometer is built in the beacon, permitting the entire field to revolve. The goniometer transmits the direction of the radio waves exactly as if the huge frame were turned.

The radio beacon, which was delivered by the Aga-Baltic Company, in Stockholm, consists of two Atlas-Diesel motor-generators, one Jungner battery, an antenna mast, and sending and receiving apparatus. It operates automatically, being started and stopped by means of contact chronometers. All the personnel has to do is to keep the battery charged and now and then adjust the chronometers according to time signals.

What makes this radio beacon unique is that the signals can be picked up by ships equipped with nothing more expensive than an ordinary crystal set. The intricate radio-sounding apparatus is all located within the beacon. Therefore the smallest fishing boat can find its way in fog and darkness.

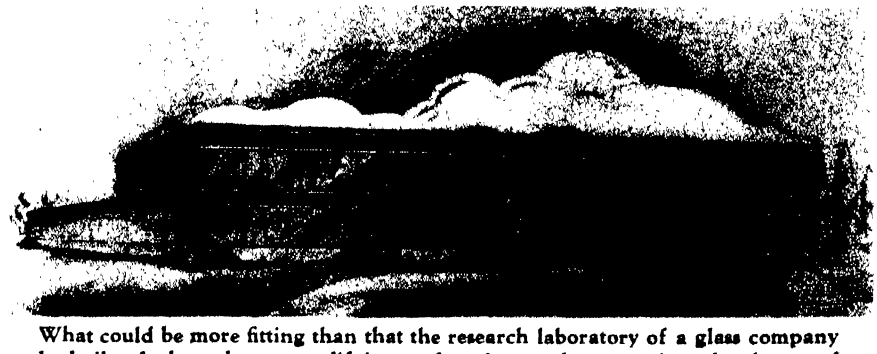
The construction of the beacon was made under the supervision of Frans Franson, staff engineer of the Aga-Baltic. The entire machinery was shipped overseas to the open and unprotected coast at Rumeli, and thence on mule-back to the tall rock on which the tower stands.—*Holger Lundbergh.*

SEASICK FISH

FISH can get seasick! At least cod-fish which were being transported in a tank on shipboard, after some time ashore in a tank, manifested the usual symptom of seasickness—loss of their dinner. This was reported by R. A. McKenzie, marine biologist.

Trench Mouth Increase—Poorly-Cleaned Beverage Glasses

AN increase in trench mouth and possibly other serious diseases has been laid at the doors of taverns and eating establishments serving alcoholic beverages, by Dr. Don Chalmers Lyons of Jackson, Michigan. The increase in these diseases has probably occurred because beverage dis-



What could be more fitting than that the research laboratory of a glass company be built of glass, thus exemplifying and testing at the same time the theory of glass buildings? The drawing shows the design of the research laboratory built by the Owens-Illinois Glass Company, entirely of glass blocks. It will be a modern wonder of air conditioned comfort and natural lighting, with no windows, roof insulation of glass wool, and glass wool filters in the air conditioning system

pensing establishments are not using proper methods of cleaning their glasses, Dr. Lyons charged in a report to the Society of American Bacteriologists. He found large percentages of the trench mouth organism and other disease "germs" on the rims of glasses racked on the bar and ready for use, and also on glasses rinsed after their return from the customers.

The findings of this study and of a similar one by Drs. W. L. Mallman and W. L. Chandler of the Michigan State College suggest, said Dr. Lyons, "the necessity for better control of methods of glassware cleansing in such establishments."—*Science Service.*

New Color Analyzer

WHITE is simply white to many people, but to a new instrument white is a mixture of all colors—with the result that the instrument recognizes, and labels, a myriad of whites. Ink, dye, paint, textile, paper, and other manufacturers, as well as research laboratories, have of course long recognized the existence of the multitude of shades and differences in colors, and color specification is an important part of production control.

Black is not always black; there are blue-blacks, brown-blacks, and red-blacks. Similarly, each color has a multitude of variations.

A new instrument, known as the recording photo-electric spectrophotometer, and shown by the General Electric Company, makes it easy to obtain, quickly and accurately, an analysis of the color of a wide variety of materials, either as reflected or transmitted by the sample. The material to be examined is placed in the instrument, operation is started, and in less than three minutes the operator removes a chart which shows exactly how much of each wavelength of light is reflected or transmitted by the sample. Comparisons of charts from different samples show in what respects their colors differ—whether one might have, for example, more yellow than another. With the charts available, it is possible to make the necessary color corrections.

The instrument consists essentially of a monochromator, photo-electric photometer, and means of recording their respective indications.

The monochromator is of the double-dispersion prism type, which insures a high degree of spectral purity. It is equipped with bilateral slits which are adjusted automatically for a 10-millimicron band. The wavelength range is from 400 to 700 millimicrons.

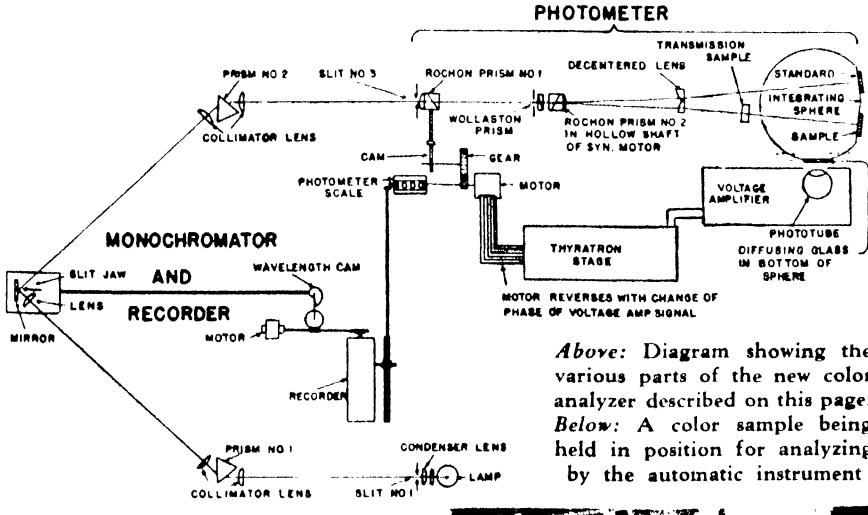
The photometer combines the polarization method of photometry with a photo-electric balancing scheme in such a manner as to eliminate from the measurements the factors of light source, phototube characteristics, and amplifier sensitivity. Reflectance values are expressed in percent of the standard selected by the operator. Transmission values are expressed either directly in percent or in terms of a standard transmission sample.

The recorder is of the drum type, in which the wavelength value is related to the drum position, and the photometric value is indicated by the pen position. Means are also provided for plotting special functions of reflectance, such as density, and logarithmic or multiplying factors.

The design is such that the recording and other automatic features may be omitted for special purposes. Thus it is possible to use the instrument as a manual, automatic balance, or recording spectrophotometer.

Courtesy Briggs Mfg. Co.

It had to come—this safety bath tub—for each year thousands of ribs are broken as a result of falls in smooth porcelain tubs; even more serious accidents happen in them. This new one, porcelain on pressed metal base instead of cast iron, has a pressed serpentine bottom and is only a third as heavy as the ordinary cast iron bath tub



Above: Diagram showing the various parts of the new color analyzer described on this page. *Below:* A color sample being held in position for analyzing by the automatic instrument

INSECT

IT is fortunate for human beings that one ancient insect became extinct. Fossil remains, discovered near Elmo, Kansas, by Dr. Frank M. Carpenter, of the Harvard Museum of Comparative Zoology, show that this particular dragon fly, which lived 150,000,000 years ago, was nearly two and one-half feet long.

Close Control of Temperature

SO sensitive that it maintains a given temperature within a range of 0.04 degrees, Centigrade, is a newly perfected instrument known as the ultra-thermostat. In most observations of physical and chemical processes the accurate maintenance of the observation temperature is of the utmost importance. The ultra-thermostat overcomes, in the simplest possible way, the difficulty of holding temperatures constant over a long period and the large expenditures in supplementary apparatus and time.

A metal vessel of about seven-liter capacity contains the bath liquid (water) which is continuously stirred by a specially constructed, noiseless, vibration-free electric motor. Heat is supplied by two electric heating units, so built as to have minimum heat capacity. The electric controlling thermometer can be set at the desired temperature between 0 and 100 degrees, Centigrade, by means of a magnet and regulates the heating units through a quartz-tungsten relay. The heating units are switched in and out automatically to hold the temperature within ±0.02 degrees, Centigrade. A pump connected with the motor delivers about two liters per minute of the constant-temperature liquid to the measuring instrument and returns it to the thermostat.

In the thermostat there is also a cooling coil through which a separate liquid can be run, if it is desired to work at a temperature below that of the room. By using the ap-

propriate liquids the range can be expended to from —25 to +200 degrees. Centigrade.

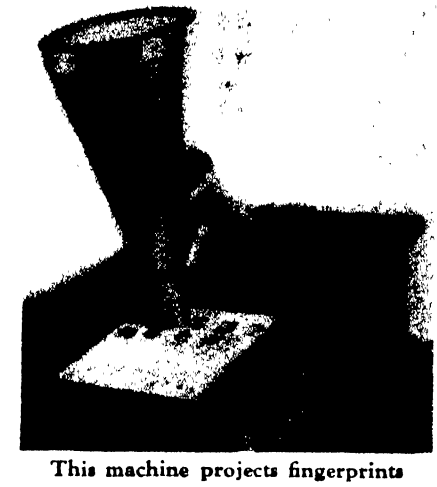
In use, the ultra-thermostat is connected to the lighting circuit and the apparatus. After a few minutes the constant temperature is reached and may be maintained for weeks without attention. - *A. E. B.*

Air Conditioned Motor Vehicles

TRAVELERS by bus or in their own private automobiles will soon be able to enjoy custom-made weather wherever they go. Details of a newly perfected system which provides air cooling or year 'round conditioning similar to that in use on railroads, in theaters and in stores, were outlined recently by Ralph F. Peo, General Manager of the Houde Engineering Corporation, a division of the Houdaille-Hershey Corporation, and E. P. Heckel of Chicago, Vice President of the Carrier Engineering Corporation, air conditioning specialists.

While stressing the fact that commercial production of these systems has not been started, it was indicated that recent engineering development has proved the entire feasibility of the principle. Research on the new system has been in progress for more than a year. A standard five-passenger automobile was used as a proving ground for the development of the system. This vehicle was in almost continuous service throughout last summer.

The system calls for the use of a refrigerating compressor driven directly by the car motor which supplies a special refrigerant to an evaporator or cooling coil located within the vehicle. A small fan draws air over the cooling coils and circulates it throughout the vehicle while at the same time drawing in sufficient outside air to provide ample ventilation for the dilution of smoke and odors. The air is filtered.



This machine projects fingerprints

The refrigerant, which is the same as that used for buildings where large numbers of people congregate, is entirely harmless, non-inflammable and non-explosive. It actually has fire extinguishing properties. The function of the refrigerant is to extract heat from the vehicle by cooling and dehumidifying the air drawn over the cooling coils. After it has done its work, the refrigerant is cooled in a condenser coil which is located on the roof of the vehicle, in the case of a bus. The movement of the car provides a sufficient flow of air over the condenser coil to dissipate the heat which has been removed from the vehicle by the refrigerant. The refrigerant is then used over again.

It is expected that several companies will equip their buses with trial installations and that a number of such vehicles will have standardized air conditioning systems in service by next summer.

The practicability of air conditioning for taxicabs, private automobiles, and ambulance service was also stressed by Messrs. Peo and Heckel, who indicated that these classes of vehicle were well adapted for air conditioning and that they foresee a growing new demand in that field.

New Fingerprint Machine

CATCHING criminals has become so active that mass production methods are being employed by the police department in Pasadena, California. The newest aid is a machine, the dactyloscope, for examining fingerprints more readily.

The old method of squinting through a magnifying glass is too tiring when there is a steady stream of prints all day long. The new fingerprint machine projects the image of a print so that it can be viewed in normal posture and with both eyes at once. Moreover, several observers can see the image at the same time.

The projection screen is not at a distance as in motion pictures but only about two feet from the eye. This arrangement enables the expert to make, in a few seconds, a tracing of the enlarged fingerprint which may then be compared with a latent print taken at the scene of the crime or with suspected prints in the fingerprint files.

The new apparatus has also been found useful for the study and measurement of written and typed material and, in fact, is used as an "eye-of-all-work" at Pasadena Police Headquarters. -*Science Service.*

OYSTERS

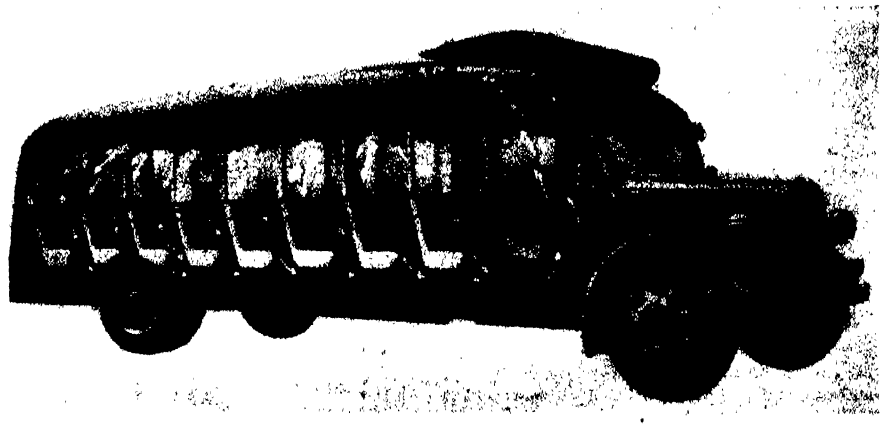
A BARREL of water is filtered through the body of an oyster in one day, according to a report of Dr. T. C. Nelson of Rutgers University. As this water is pumped through, the minute plants which are the oyster's food are sifted out and enough oxygen is obtained to keep the oyster's modest vital fires.

Boron Wearing Surfaces for Metal Parts

TWO methods of applying metallic boron crystals to the surface of metals for the production of wear- and corrosion-resistant surfaces have been developed by Colmonoy, Inc. The "sweating-on" method mixes the crystals with sodium silicate to form a stiff paste which is then coated over a surface to be processed. Sufficient heat is applied with a torch or arc to sink the crystals into the parent metal. The second method, the "cast-on" process, employs a mixture of crystals in a matrix of nickel alloy with a lower melting point than steel which is melted and poured on the surface, within a mold. The overlay fuses securely to the parent metal. *A. E. B.*

Marihuana Menaces Youth

MARIHUANA smoking has spread so rapidly that the drug has become a serious menace, particularly among youthful lawbreakers. The drug, also known as loco weed, muggles, Indian hay, Indian hemp, hasheesh, laughing tobacco, and reefers, is dried and rolled into cigarettes selling from



Above: **Air conditioning for a standard motor car.** ***Right:*** **Bus equipment. A is the compressor, B the cooling coil provided with a filter, C the fan, D the distribution ducts, and E the condenser cooling coil that dissipates heat extracted from the interior of the vehicle**

five to 25 cents apiece. From 300 to 500 cigarettes can be made from a pound, making it highly profitable for its underworld vendors.

Marihuana produces a wide variety of symptoms in the user, including hilarity, swooning, and sexual excitement. Combined with intoxicants, it often makes the smoker vicious, with a desire to fight and kill.

Addiction to the drug is common in Mexico and some authorities have estimated that as many as one out of every four persons in some of the southern states are users. Out of 450 prisoners examined in New Orleans in 1930, 125 were found to be addicts. Despite the vicious effects of marihuana, only 17 states have laws against it and its control is not yet included under the federal Harrison narcotic act.

16TH CENTURY BETHWACKMENT

MERRIE England, in the lusty days of Henry VIII, Will Shakespeare, and Good Queen Bess, was probably the thumpingest, flailingest, battering, and bumfeagling nation the world has ever known, judging from word research on the Early Modern English Dictionary being edited at the University of Michigan.

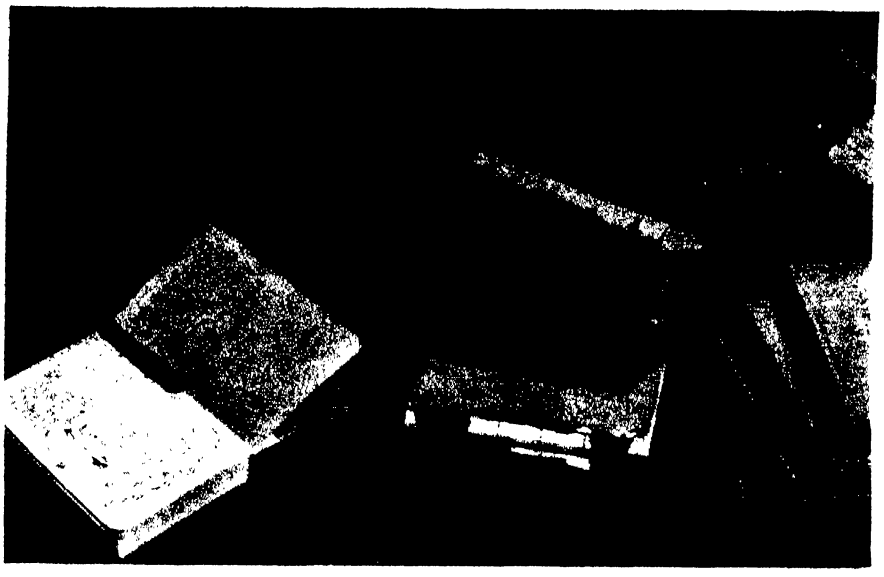
This discovery that the 16th Century beat all as a banging time grew out of a three-letter word, "lam." "Lam," with the meaning of "to strike," first appears on the verbal field of battle in the middle 16th Century. Writing in the Michigan *Alumnus Quarterly*, Dr. Leo L. Rockwell tells how the dictionary staff lashed and mauled their way through a tangle of words to isolate all forms of assault and battery.

Before 1200, they found, one gentleman might only threaten to beat, buffet, fell, hit, knock, smite, or thrash another gentleman. Before 1300, however, bob, bounce, ding, dint, gird, squat, and tap were added to the vocabulary of violence; while, by 1475, such terms as bat, batter, bless, bunch, chop, clap, clod, dab, flap, flash, hammer, lash, lay on, maul, pop, rap, scour, staff, whip, crack, dress, flail, knap, nape, pash, pelt, skelp, spar, and wale had appeared.

Then came the 16th Century when apparently every solid Britisher must have spent a good share of his time in thumping, or at least threatening to thump, his neighbors. Blessed with a good memory, a subject of Queen Elizabeth might drub his enemy verbally with the following 83 types of mayhem: anoint, bang, baste, bebang, bebat, bebaste, bebatter, becudgel, becurry, belam, belay, bepommel, besoop, beswaddle, beswap, bethump, bethwack, box, breech, bum, bumbaste, bumfeagle, bumfeg, bumfiddle, canvass, chock, clapperclaw, claw, club, coil, colpheg, comb, cudgel, cuff, curry, douse, ferule, filch, fillip, firk, fist, flip, flirt, gag, jerk, jut, kemb, knack, lace, lam, lamback, lambskin, lick, lump, nevel, pat, pay, pummel, punch, ribbaste, ribroast, shock, souse, slash, slat, stab, swaddle, swash, swinge, taw, thump, thwack, tick, tickle, tip, trim, trounce, twig, walk, wherret, whisk, whop, yerk.

After that socking 16th, the succeeding centuries seem wan and weak. Only a few really good solid terms of bethwackment arose, such as belt, bebump, flay, lambaste,

(*Please turn to page* 161)



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THE use of wooden tubes instead of metal, for amateur's telescopes, is apparently increasing. They are believed to give less trouble due to temperature effects, for example, atmospheric "boiling," which is often thought to be high aloft, when much of it actually takes place within the telescope itself. On this page are four photographs of wooden tube telescopes. Figures 1 and 2 show a telescope made by Horace E. Dall, 166 Stockingstone Road, Luton, Beds., England, who writes: "I am enclosing a print or two of my latest complete telescope—a 10" Newtonian equatorial with circles. The tube is of the square plywood type, which I favor on account of freedom from air current trouble. The mounting uses an 18" face plate on rollers—very rigid and sweet running. I did the optics—all the lathe and instrument work, including the circle engraving, slow motion clamps, and so on. A local friend, Eric Perry, did the woodwork, concrete and cast iron work,

Figure 1: **Wooden tube. Dall**

patterns, and so on. The R.A. circles are 20" and the decl. 12" in diameter. The telescope is delightful to use—extremely crisp images—in and out of focus star disks dead alike. The figure was perfect to my measures and no scratches. A parson in Norfolk (Eng.) now uses it."

THE photograph in Figure 3 is that of Max Papkoff, 382 N. 19 St., Salem, Oregon, and his 8", square, wooden tube telescope. Mr. Papkoff states that he cemented a disk of ⅜" plate glass to a thick piece of wood and made his mirror thus. By all rules, laws and sacred traditions, such a mirror ought to be badly flexured, especially when the wooden backing warps due to intake of moisture. Yet he says it gives sharp, distinct star images with a half-inch eyepiece. Several amateurs are similarly known to be flirting with thin mirrors, backed and unbacked in type, and we hope later to publish a few statements from some of them (more are solicited).

Figure 2: **Mounting. Dall**

This question may not be so simple as it appears. Perhaps it is not one to be settled merely by citing "rules." It is suspected that the thin disks sometimes stand up on their own account, regardless of supposed assistance from the wooden, metal, or glass backing to which they are attached either rigidly or the reverse. The 1:6 or 1:8 ratio usually demanded does, of course, allow for a big factor of safety. When a thin disk performs well, would it have performed equally well without the backing? Unscrambling the several complex considerations involved in this whole question, and making a really scientific analysis, would be a nice job for someone. No general deduction made from one, two or three or less than a dozen or so of mirrors made of different glass would seem to be very safe. Hence, a big job. A writer in the *Journal of the Royal Astronomical Society of Canada,* July-August, 1935, seemed pretty dogmatic about the matter, attacking the 1:8 ratio recommended in "A.T.M.," and another Canadian has requested us to answer his article, "taking the other side." But we do not wish yet to take any side in this argument, for it is possible that there is insufficient data as yet to back either side very positively. This taking sides and arguing business too often obscures matters that ought to be handled with more light than heat. We need more light.

Figure 3: **Wooden tube. Papkoff**

The wooden tube telescope (Figure 4) is hexagonal and was made by Ellsworth Mebold, a commercial artist, Marine, Illinois.

Recruits are wanted for the "Wooden Tube Club."

A FEW numbers back we suggested that someone work out a dingbat by means of which an old hand at mirror testing could coach a rookie, the two (or any other two) being able to watch and discuss the same shadows at one time. William Scott, Glascock Reynolds, and Louis Mobley, 140 Westminister Drive, Atlanta, Georgia, sent in the photograph shown in Figure 5. It shows a typical test rig, plus a diagonal

Figure 4: **Wooden tube. Mebold**

sheet of flat glass at a 45° angle, placed between mirror and knife-edge. The glass is very thinly silvered. (This is easy—just set out to get a thick coat.) These three complain that they have to place their cheeks "affectionately close" in order to see well. Their whiskers became tangled. Chester Silvernail, 5151 Bristol Road, San Diego, California, proposed a similar set-up, to be combined with a Ronchi rig like the one in "A.T.M.," page 266, Figure 3.

THE following is from J. J. Ruiz, M.S., D.Eng., 1065 Park Ave., Schenectady, N. Y. "Many an amateur telescope maker, while walking around his barrel, must have speculated, at one time or another, about the size and shape of his Carborundum and of the pits and holes on his glass. Being an

amateur microscopist as well as a telescope maker, I set myself the task of finding out, and here are some photomicrographs showing what I found. Figure 6 shows what the abrasives look like under a magnification of approximately 80 diameters. They are Nos. 80, 280 and 400 Carbo, and the last is No. 800 emery. Note that the emery does not show the sharp splinters and corners of Carbo, which explains why the final fine

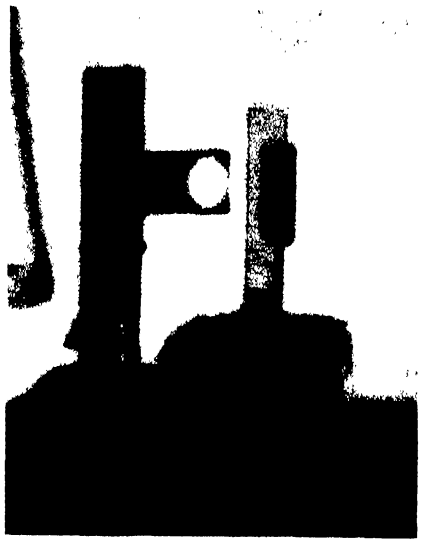

Figure 5: Two-man test rig

grinding with emery gives a smoother surface. Figure 7 shows the appearance of glass under vertical illumination when ground with No. 80 emery, No. 280 Carbo and No. 800 emery. The magnification is approximately 100 diameters. [For the time being, the photo in the lower right-hand corner may be ignored. -*Ed.*]

"Using the method suggested in a previous number [First focusing the microscope on the level parts between the pits—after a small amount of polishing—and then on the bottom of the pits, and measuring the distance between these two focal planes by means of a micrometer attachment.—*Ed.*] the depths of the pits left by the different grades of abrasives were measured. The microscope was provided with means for vertical illumination, and a dry 3-mm. objective was employed. The averages of several measurements give the following:

Grade	Material	Depth of pits in microns. (One micron=0.000039 in.)
80	Emery	16.3
220	Carbo	11.2
280	Carbo	6.6
400	Carbo	4.1
600	Carbo	2.5
800	Emery	2.0

"The pits left by No. 80 emery are not proportionally so large as those left by 220 Carbo. This is probably because the large grains break down easily under pressure into finer grades. Note in this connection the appearance of the ground surface shown in Figure 7."

An attempt was made to correlate the figures which Mr. Ruiz gives for pit depths with those for abrasive size, given on page 493 of the new (fourth) edition of "A.T.M." While more data on more sizes of abrasive would perhaps better define a rule, it was apparent that pit depth is at least approximately proportional to grain diameter.

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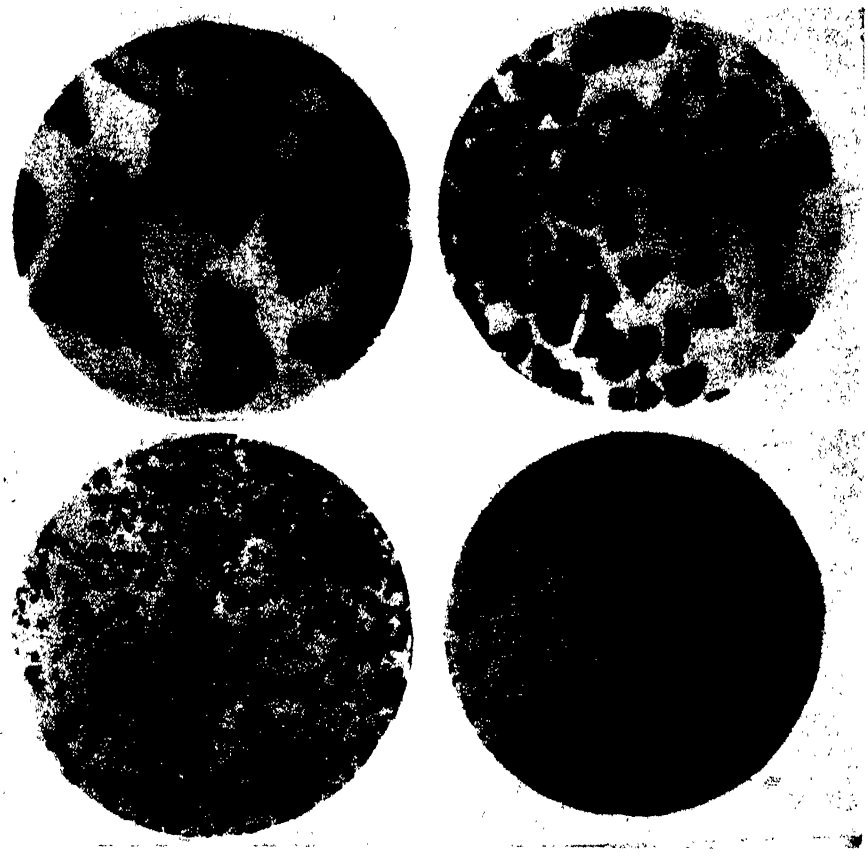

Figure 6: Top: No. 80, 280 Carbo. *Bottom:* No. 400 Carbo, 800 emery

The big professional manufacturers have (secret?) data on this.

Mr. Ruiz continues: "When we come to rouge, we find that it is in a class by itself. The lower right-hand photomicrograph in Figure 7 shows rouge under a magnification of approximately 800 diameters, or ten times that of the previous photomicrographs. The diameter of the rouge grains is about 0.7 micron (0.000026 inch) which is only a thousand times (more or less) the diameter of a water molecule. A suspension of rouge in water can be used to show the Brownian movements caused by the random impacts of the water molecules. Every amateur telescope maker who has access to a microscope with an oil immersion lens ought to perform this experiment."

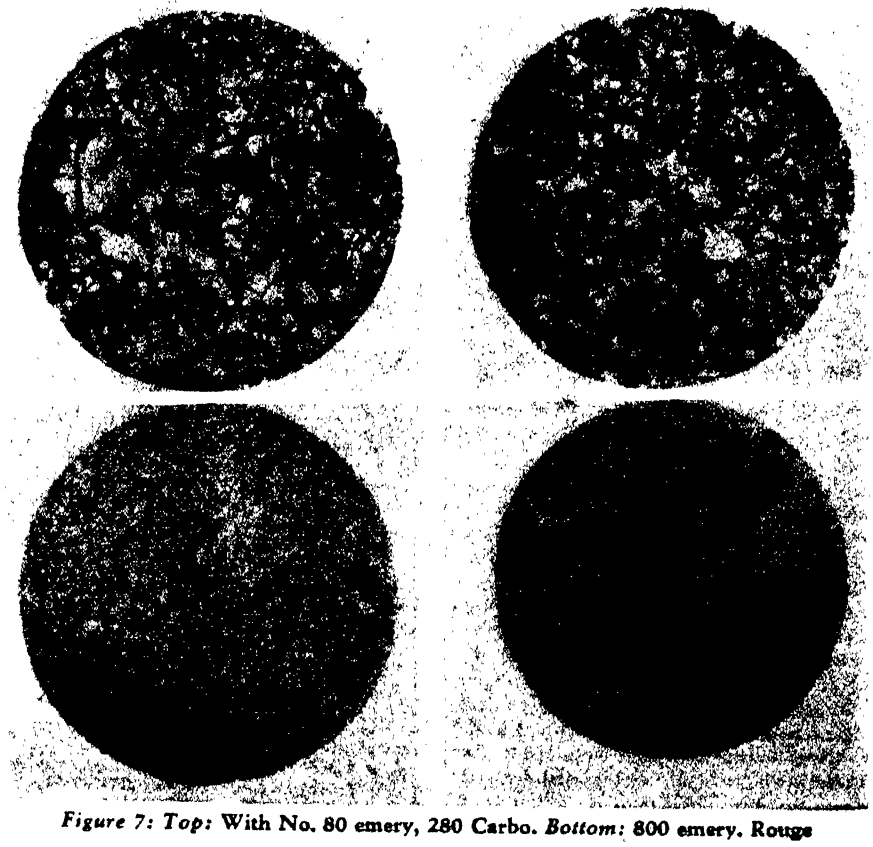

Figure 7: Top: With No. 80 emery, 280 Carbo. *Bottom:* 800 emery. Rouge

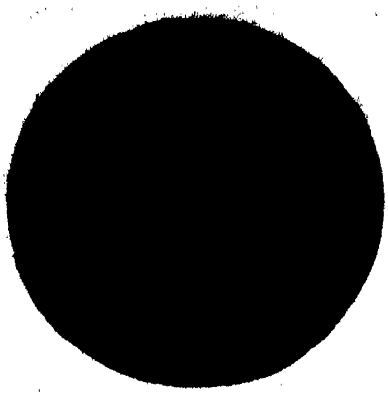

Figure 8: Glass after scoring

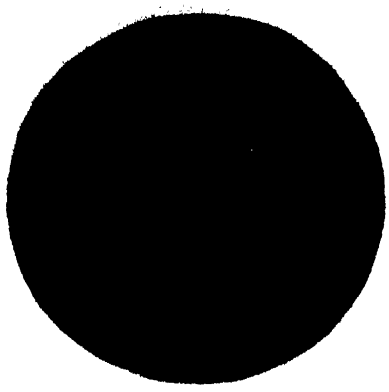

Figure 9: Same after polishing

MR. RUIZ next takes up the question of the actual nature of the polishing operation—sub-microscopic planer work or molecular flow (the "butter" theory—which is discussed in "A.T.M.," pages 326-331, but which has never been settled).

"The process of polishing," he says, "is different from that of grinding. Years ago Lord Rayleigh advanced the theory that polishing is essentially a process of plastic flow of molecules from the hills into the valleys, although undoubtedly there is some removal of material which is not deposited. Figures 8 and 9 show the results of an experiment by the author which bears out this theory. Figure 8 is a photomicrograph of an ordinary piece of plate glass which has been scored with a splinter of Stellite; the magnification is approximately 100 diameters. The glass was then polished with rouge on pitch, using considerable pressure, until all the scoring had completely disappeared when examined under the microscope. Chemists tell us that a substance on which energy has been spent is less stable, so that if we etch the glass with hydrofluoric acid, we may expect that the acid will attack and remove more readily the material deposited in the grooves. Figure 9 was taken after the glass had been etched with the acid, and it will be seen that the original pattern of the scoring is brought out more or less. The scoring was not of uniform depth, which explains why some of the lines have disappeared almost completely. The distortion of the lines shows that there has been plastic flow of the material. The numerous random light scratches were caused by carelessness in polishing."

These results are in favor of the butter theory. Most scientists who have investigated favor that theory—most practical opticians the other.

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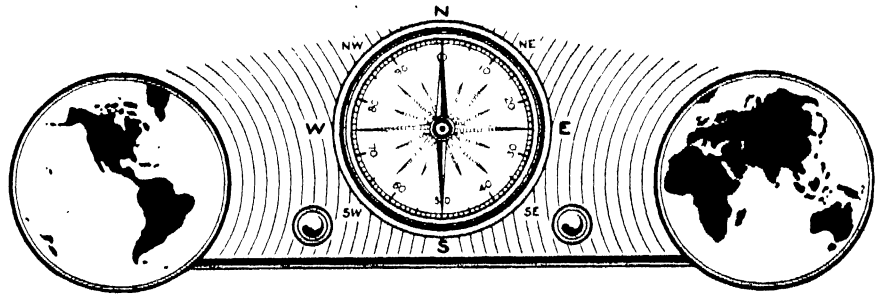

WORLD-WIDE RADIO

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AUTOMATIC VOLUME CONTROL

RECEIVERS having automatic volume control may prove to be excessively noisy when tuning from station to station, due to the fact that the sensitivity of the receiver circuit reaches maximum at such intervals when there is no signal voltage.

The automatic volume control is really not a volume control at all - it is a sensitivity or gain control, but since an increase in sensitivity or gain also produces an increase in signal volume, the term applies.

The operation of an automatic volume-control circuit is not difficult to understand. A portion of the rectified signal voltage is fed back to the control grids of the amplifier tubes. This voltage is effectively negative, and the greater the negative voltage impressed on the grids of the amplifier tubes, the less the amplification. Since the value of this negative voltage is dependent entirely on the strength or voltage of the received signal, it is obvious that the weaker the signal the less negative voltage there will be to impress on the amplifier tubes. Consequently, the amplification or gain is of a high degree. If the signal strength is of a considerable value, the negative voltage impressed on the grids of the amplifier tubes will be greater, and in consequence the amplification will be less. The net result is that irrespective of the strength of the received signal, the output will remain at a fairly constant level.

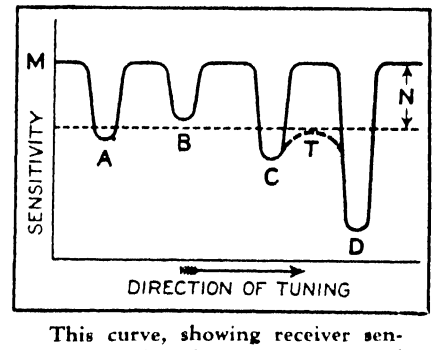
It is evident from the foregoing that if no signal is being received, there will be no negative voltage on the grids of the amplifier tubes, with the result that they will operate "wide open," so to speak. Under this condition of maximum sensitivity, local noise is greatly amplified, which accounts for the racket when the receiver is being tuned from one station to another.

The accompanying sketch serves to illustrate this action. In the sketch, the receiver sensitivity is plotted against the motion of the tuning dial pointer. The point M represents the maximum sensitivity of the receiver.

It will be noted that as the tuning dial pointer is rotated (this corresponding to the direction of tuning in the sketch) the receiver is at maximum sensitivity until broadcast station A is reached, at which point the sensitivity is levelled off to a point which provides the correct amount of signal voltage to maintain equal volume output with respect to other broadcast stations.

As the tuning progresses, the receiver again reaches maximum sensitivity as there is no signal voltage to hold down the gain. However, as soon as the receiver comes into tune with broadcast station B, the sensivity again decreases to a value that will provide the same volume output. The same is true for stations C and D, and so on.

It will be noted that the dips in the curve are not uniform; neither are the signal voltages received uniform. Thus A represents a moderate signal, B a weak signal, C a strong signal, and D a very strong signal from a nearby station. When station D is being received the sensitivity of the receiver is at a very low point, and there



This curve, showing receiver sensitivity plotted against motion of the tuning dial pointer, illustrates the operation of automatic volume control. A full explanation of the important action that takes place in a receiver is given in these columns

is little, if any, possibility of hearing anything but the loudest local noise or man-made static. On the other hand, the signal from station B is so very weak that high sensitivity is required to bring it up to an equal volume level. The result is that local noise is also amplified.

Every locality has a definite "noise level" below which satisfactory reception cannot be had. An arbitrary noise level is indicated by N in the accompanying sketch. Any signal so weak that the degree of receiver sensitivity falls within this area will be a signal accompanied by noise—such as with station B.

An automatic volume control is actually an anti-fading device; that is, it will, within limits, keep the volume level of a fading signal at substantially the same value. This means that if the signal from station A should commence to fade, the sensitivity or gain of the receiver would automatically increase. Thus station A might cause only a slight dip in the sensitivity curve one moment (such as at B) and a large dip (such

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

as at D) the next moment. But, irrespective of the strength of the signal, the output volume level would remain substantially constant. The only discernible difference to the ear would be that, during the period when the signal was very weak (such as at B), the noise level would be audible. You can demonstrate this action very nicely by tuning in a distant station and noting the rise and fall of the noise level in the background.

Not all receivers equipped with automatic volume control are noisy between stations. As a matter of fact, it is common practice in the better receivers to introduce a time lag or a delay action to the avc. This is represented by the dotted line T in the sketch. In this instance, the automatic volume control does not release the tubes instantaneously, with the result that when tuning from station C to D, for example, the receiver does not return to full sensitivity at once. The process is gradual, and since a listener tunes from one station to another quite rapidly, sensitivity, and therefore noise, is held down.

Cuban 'Phones

THE Cuban Government has authorized the use of a portion of the 40-meter amateur band by Cuban amateur radiophone stations—stations having calls with the prefix "CO". The specific channel opened for 'phone use extends from 7000 to 7100 kc. United States amateurs are not permitted to use radiophone transmitters in the 40-meter band. It has been set aside for use by amateur radio-telegraph stations only.

Frequency Modulation

MAJOR Armstrong's system of frequency modulation is unique if for no other reason than the fact that the greater the frequency band width employed for transmission, the less noise received. Until recently, noise has been fought with power; possibly in the near future noise will be fought with frequency bands. In either event, the Federal Communications Commission is the deciding factor.

"The Shadow"

THE mysterious form of interference reported in this department last month has occupied the attention of governmental and commercial radio agencies alike. Because of the unpredictable raids of this interference into marine, trans-oceanic, aircraft, military, naval, amateur, and probably also in the television sections of the radio spectrum, the strange radio signals have become known to engineers as "the shadow." William A. Winterbottom, Vice President and General Manager of R.C.A. Communications, Inc., has made the announcement that scientific methods are being employed to track down the source of these sounds. These radio waves have not the character of telegraphic or telephonic signals, and are definitely unrelated to any "static" or cosmic-ray phenomena within the experience of engineers. Unlike static, they are usually observed on definite frequencies. Their "fingerprints" have been taken in the form of phonographic recordings of the weird sounds they produce, and the engineers are slowly "closing in" on the answer to the mystery. Radio direction finders and cathode-ray oscillographs are other devices of modern radio science that are being employed in the hunt, the one being used to determine the direction from which the signals come, and the other to measure their phase and frequency of modulation.

"The shadow" has been most active in the frequency band between 11,000 and 14,000 kilocycles, although it has been observed as low as 6000 kilocycles and as high as 18,000.

The type of signals emitted by "the shadow" are annoying but rarely disruptive to the communications paths across which they sweep. Their interference is most serious to radio-telephone signals, which of course includes the short-wave broadcasting services that hundreds of thousands of persons in this country tune in on their all-wave receivers.

At stations of RCA and other radio companies in the eastern United States, the mysterious signals are most frequently observed between the hours of 9 A.M. and 6 P.M. But it is already known that "the shadow's" operations are by no means limited to this section of the country, for it has been observed on both coasts, and at various points in between.

As a matter of fact, "the shadow" took a hand in the recent broadcasting which attended the stratosphere flight from Rapid City. On that occasion the RCA station at Riverhead, L.I., tuned in directly on the balloon's transmitter and had perfect reception but for the interference of these mysterious waves. This caused a quick change in the technical facilities employed to bring voices from the balloon to the broadcasting networks, it being necessary to pick up the balloon's radio at an RCA station in Chicago, where the interference was not being experienced at that particular time.

So far the radio communication and broadcasting companies have had no serious difficulty in circumventing the interference caused by the mystery signals. But there is little doubt that the public who listen in on the short-wave bands have already suffered considerable inconvenience, and may expect still more in the event that the mystery is not solved shortly, for "the shadow" has become increasingly active in the United States.

Engineers are confident that, from whatever source the mystery waves may come, they are not being employed in any known form of communication. It is therefore possible, if not probable, that whoever is generating the waves may be entirely unaware of the interference they are setting up. Were they carrying intelligence of any nature, this would supply important clues to their origin. But as it is, the searchers must rely entirely on analysis of waves by scientific devices in their approach to a solution of the mystery. It has already been determined that the power sources of the waves are of two types; on some occasions the signals are produced by half-wave rectified power, and on others by a full-wave rectified source.

It is understood that engineers of the United States Navy Department have attributed at least part of the weird interference to radiations from high-frequency "fever machines" used in hospitals. But whether "the shadow" is, after all, a "multiple personality," arising from a number of sources, is still to be finally determined.

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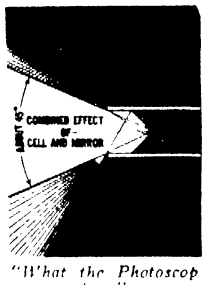

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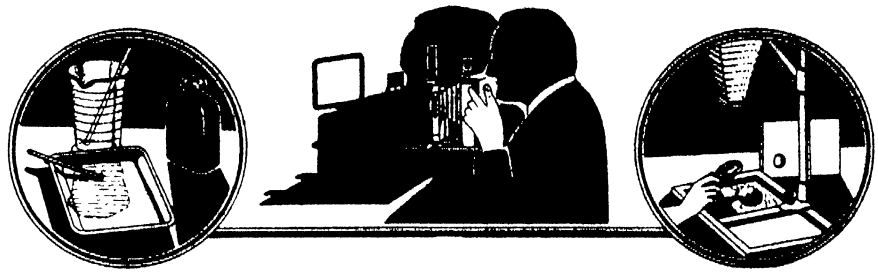


CAMERA ANGLES

Conducted by JACOB DESCHIN

Much in Little

THE epigrammatic form of expression may be employed by the photographer as forcefully as by the orator and author, if the camera worker will concentrate his lens on the particular feature of the human anatomy, inanimate object, or what not, that appears to him to fit his interpretation

"Pipe Dream"

of character, mood, atmosphere, or of some original idea.

He may slice a head, for example (but "gently, brother, gently, pray"; that is, with an eye to composition, for one thing), or he may emphasize in his picture only eyes, or feet or hands, a significant crook of the elbow or the graceful curve of a woman's neck. This dramatization of detail will often tell more within its small scope than would the inclusion of the entire figure or object, without the annoying distractions and superfluous material which the latter too frequently entails.

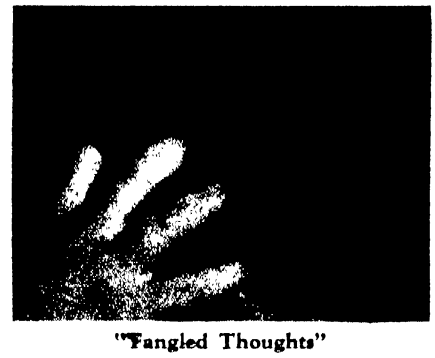
Composition is all-important. A "much-in-little" photograph will stand or fall on the correct placement of the chief point of interest within the framework of lines and curves, few though they may be. Failure in this regard will, more often than in other types of photographs, mean failure of the idea in the photographer's mind to be realized on paper. Good composition will provide emphasis where it belongs, and correct emphasis for a well-conceived idea will mean a striking picture-story.

Since interpretation and not realistic presentation is the method employed in producing this type of photograph, the usual rule of standing well off from the subject in order to achieve good perspective may be ignored for the time being. So, using ordinary common sense and guided only by the idea, crawl up as close as you need to or as the lens will permit. A short-focus lens will do wonders here, but the regular lens, and, of course, the telephoto will often serve.

Incidentally, if the particular lens you have will not give you just the small portion you want, take whatever else goes with it and compose your picture by enlargement later.

Treatment of an epigrammatic picture may be grotesque, with serious, humorous, or serio-comic implications, or, within its sphere, may be fairly straightforward. Thus, "Pipe Dream" might be included in the former category, and "Tangled Thoughts" in the latter. Because of the abrupt point of view, distortion is unavoidable, and, in fact, desirable, but distortion here means something else again from the meaning of the term as it was discussed in our February issue. Distortion here is a means employed for the projection of a thought; in the other case, a deliberate, manual procedure during enlargement to produce caricature.

While epigrammatic pictures generally are made after much planning, it is surprising how often some of the best sugges-



"Tangled Thoughts"

tions will come in the course of arranging the subject and in varying the position of the camera. Material lies everywhere and may be used for other purposes than to express an idea or emotion. Thus, a broken egg shell, the spokes of a wheel, an interesting design noted in, perhaps, some commonplace household object, may be sufficient justification for a picture if the arrangement and lighting are so executed as to give joy in pure line and the satisfying contrast of light and shade.

The photographer is at liberty in this type of work to shift his material as he sees fit and sometimes in a grossly unorthodox manner. Thus in "Pipe Dream," the subject's

head was originally in a horizontal position; also, the picture is a print made by combining two negatives, one being reversed, although this could just as well have been done by taking the second negative in the reversed position in the first place. But then, the photographer did not think of the final

"Contrast"

print until he started arranging his material in the darkroom, so this offers another chance for working up an idea or completely revising the original one.

Thinking about epigrammatic pictures and playing with ideas while studying the possibilities of the humblest material that greets the eye are good training in composition and in noting in sticks and stones pictorial sermons well worth photography.

Still-Movie Camera

A COMBINATION motion picture and still camera selling at an extraordinary low price is shaped something like a movie camera, loads 10 feet of film at a time, and may be operated continuously for this length for movie work, or 40 pictures may be snapped off in quick (or otherwise) succession. If the exposures are made in quick succession, prints are later made up into book form in the order in which the exposures were made. Flipping these 40 prints quickly gives the illusion of a movie.

Fine Grain Developer

A NEW fine grain developer which has been attracting favorable attention is the Eastman Ultra Fine Grain Developer, which comes handily packaged in pint and quart cartons. The latter is more economical to purchase since the cost is only a third more than that of the pint.

Giving the fine grain results of paraphenylenediamine types of developer but without their slowness, the new developer allows the same maximum enlargement, exposure latitude, and film speed, is stainless, non-toxic, keeps well in solution and has great developing capacity, being as simple to use as the tried-and-true "M-Q." Speeds of development at 65 degrees are 10 to 15 minutes for such films as Panatomic and 15 to 20 minutes for "superpan."

Screw-In Mounts

SOME persons find difficulty interchanging lenses on screw-in mounts, preferring for that reason camera bodies equipped with mounts of the bayonet type. We know that reasonable gentleness and caution in starting the lens or filter on its circular course are the whole A, B, C of the problem, and the "knack," if any, lies merely in bringing the lens down level with the mount and carefully sliding the lead end of the threading of the lens into the grooves of the mount. It may be helpful to some not to attempt to interchange lenses while holding the camera in the hand but to first place the camera on its back on a table or other flat surface.

"Bulletin" Board

A PLACE for everything and everything in its place is the rule in the darkroom of the worker who aims for perfection in his pictures. In one darkroom a piece of Beaverboard measuring 12 by 18 inches was nailed to the wall, in the corner where solutions are weighed out and mixed. Manufacturers' formula sheets and formulas copied out of books and magazines or obtained from dealers or fellow workers are thumb-tacked to this board and are there whenever wanted. Another use for such a "bulletin" board is for a list on which needed items are noted as they approach the vanishing point. There is nothing so exasperating and so dampening to enthusiasm as being short of some chemical ingredient when we have gone half-way through the process of mixing a formula, or finding during a heavy evening of printing that we lacked sufficient paper to complete the program we had set for ourselves.

Easel Copying Stand

A VALOY enlarging easel was pressed into service for a copying stand on one occasion and found very serviceable. The easel was placed against a wall with the original upside down in order to get a right-

How an enlarging easel may be used to hold a photograph for copying

side up view on the ground glass. A vertical picture, of course, can as easily be taken by resting the easel on a table and shooting down. The easel guides furnished ideal margin rules and, being of metal, held the picture rigidly.

Focusing Aid

THOSE who have found difficulty looking for a negative that could be scratched so that on projection the sharp lines could be focused—the damaged negative to be replaced by a good negative which could not

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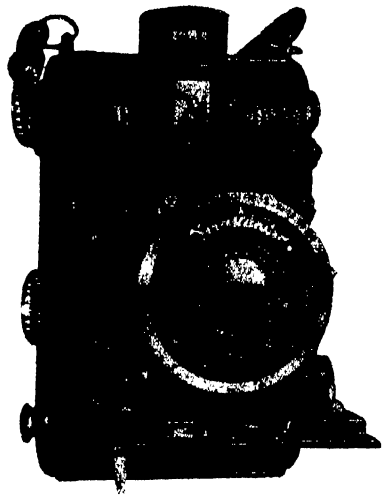

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By Lieut. Col. George R. Hutchinson

This is a story of the four Hutchinsons—father, mother, and little Janet Lee and Kathryn—whose flight to Greenland a year or two ago attracted so much attention. It tells the intimate story of their airplane journey while attempting to make a trip across the Atlantic, of their disappearance, and of their final rescue. It is as much a story of adventure as it is an epic in the annals of aviation progress. Written for youths and grown-ups alike.- $2.15 postpaid.

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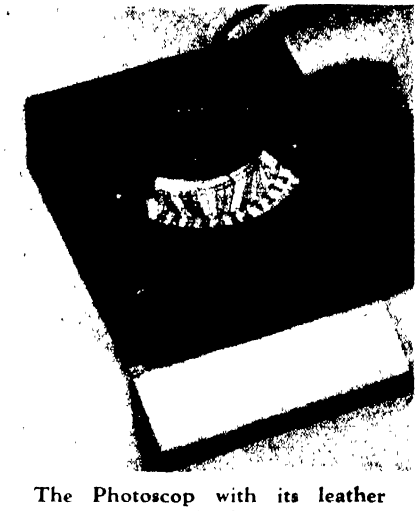
properly be focused because it was over-dense or for some other reason—will welcome a device known as the Exakt that does the job much better. Coming in sizes ranging from 35-millimeter to 9 by 12 centimeter, the device is a film, in the center of which is a negative the size of the negatives being used. This negative, instead of the haphazard scratches aforementioned, consists of fine dots and geometric figures, which are easily focused. All the lines should focus sharply, thus affording sharp definition; one worker has found that he can focus best with the dots, others may find they can do better with the lines.

New Photoscop Arrives

FINAL details on the new Photoscop photoelectric exposure meter have been made available with the appearance of the instrument on the market. Designed for still and motion picture photography, it is of vest-pocket size and comes in an "ever-ready" leather case which may be swung from the neck by a cord.

In describing the original feature of the new meter - the inclined photo-cell and mirror—the distributor says that it "limits the angle of measurement to only about 45



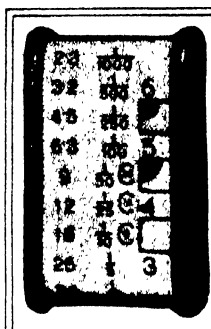
The Photoscop with its leather case open, ready for instant use

degrees of photographic importance; only about 20 degrees above the meter axis, and about 25 degrees below the horizontal plane of the meter. The region directly in front and just below the horizon is favored. The 'top-light' influence, which is so frequently interfering in exposure meter reading, is completely eliminated."

The new Photoscop gives direct readings after pre-setting of the film speed and the generally used shutter-time of the still-camera or the "taking-speed" of the motion picture camera. A red pointer swings into position on the dial when the meter is pointed at the object, giving instant reading.

The meter gives readings from 30 seconds to 1/1000 of a second, with cinematic taking speeds ranging from 8 to 96 frames per second. Film speeds are from 14 degrees Scheiner (Kodachrome speed) to 29 degrees.

The statement is made that "the new Photoscop will cover every fairly adequate illumination, daylight or artificial light, in which the vast majority of pictures is taken, and which is necessary for attractive results."



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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 151)

raddle, slam, sock, and whang. The coming of dictionaries and formal correctness slowed up the flow of homely language.

But the present century gives some hope. "It is too early to make more than a surmise," says Dr. Rockwell, "but no devotee of the funnies can fail to read the signs of the times." In the vigorous style of modern fiction he also sees words which will force themselves into standard usage. "He that has ears for hearing, let him sharpen them and he will surely hear the grass growing in the field of verbal lambastics."

Sad State of Nation's Timberland

THE completed report on timberlands in Minnesota—the first state to be surveyed in a nation-wide inventory by the Forest Service—is called a "picture in miniature" of the forest situation in the United States. It shows that "a century of use and abuse has made a profound change in forests." It shows "conditions typical of many states where destructive clearing and lumbering" have been common. But it also has brought together facts important in forming new programs of conservation and rehabilitation in all states.

Of an original forest area of 31½ million acres in Minnesota, there remain today only 19½ million acres, much of which is classified as "forest" for lack of a better name. Actually, 21 percent of it has no tree growth, and 38 percent is occupied only by aspen and scrub oak. Only 41 percent retains any semblance to the original types.

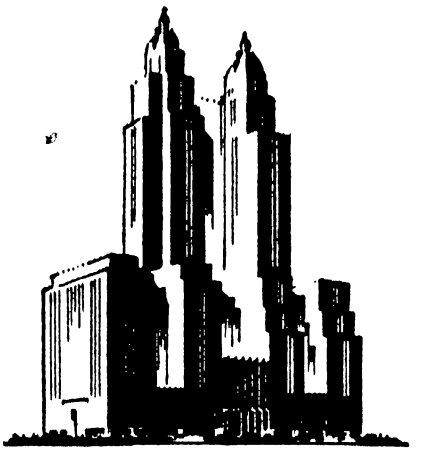
The changes in size and quality of timber are striking. The original forest contained at least 10,000,000 acres of old growth pine, spruce, and hardwoods. The present area of old growth saw timber of all types is only 343,000 acres or 3 percent of the original. Ninety-seven percent of this kind of timber, which was the mainstay of the lumber industry, is gone.

A few areas in Minnesota—such as the Superior district and the Chippewa National Forest—indicate what may be expected of cut-over lands with reasonable care and protection. The Superior district, burned over almost completely 70 years ago, now has more than 300,000 acres of second growth nearing merchantable saw-timber size and nearly a million acres of cordwood forest, over half of which is in valuable pulpwood types.

Mosquitoes Cause Many Deaths in U. S.

BECAUSE so much publicity has been given to the remarkable eradication of yellow fever throughout the world by control of the particular mosquito which carries the germs of that disease, the erroneous belief has sprung up that mosquitoes no longer are important agents of disease, points out the American Institute of Sanitation.

"Close to 3000 persons in the United States die annually from malaria, which is



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caused solely from the bite of anopheline mosquitoes whereby microscopic parasites are introduced in the body to live in the red blood cells," says the institute.

"But the death rate from malaria is no true index of the human misery caused by mosquitoes. For every person who dies from malaria there are dozens who are partially incapacitated by the affliction. A person may suffer from the disease the greater part of his life with a reduction of productive capacity of 50 percent or more, yet he may finally succumb to an entirely different ailment. Although rarely fatal, malaria undermines the constitution and resistance, with the result that the victim easily contracts other ills."

Hydrogenation Ages Whisky

A NEW and promising method of removing "greenness" from freshly distilled whisky is described by Hochwalt, Thomas, and Dybdal in *Industrial and Engineering Chemistry*. Hydrogenation of the fresh spirits, accomplished by passing hydrogen through it in the presence of a nickel catalyst, is said to do the trick. The disappearance of the disagreeable odor and taste is the immediate obvious change that occurs on hydrogenation of freshly distilled spirits. The compounds which cause the unpleasant odors and taste known as "greenness" and which prolong the maturing period are changed by the reducing action to odorless and tasteless bodies. Both physical and chemical methods have been unsuccessful in detecting any change in the hydrogenated product; for example, only the empirical tests such as taste and odor, which are extremely sensitive, show the difference of the hydrogenated product. —*A. E. B.*

Latex Coated Textiles

THE development of a new process for coating textiles with rubber latex promises to call forth a large industry. First products to reach the consumer market are ordinary canvas work gloves. These are made by dipping into or spraying with a vulcanized rubber latex solution and then drying. The advantages of this process are extreme simplicity and low cost, while for the product itself are claimed a double or quadruple wearing life, depending upon the use to which the gloves are put, a resistance to many acids, and added warmth. Non-slip qualities make them admirably suited for driving; non-wetting qualities promise use for children's winter mittens.

This process is also being applied to work clothes such as overalls and for the making of substitute oil-skins. The latter features non-stiffening when subjected to low temperatures.

Antidote

AN antidote for otherwise fatal poisoning from overdoses of commonly used luminal, veronal, and related sleeping powders has been found in picrotoxin, a drug formerly much in vogue but little used in recent years. Two human cases in which the new treatment proved its worth, and animal experiments leading to its use, were reported by Drs. T. Koppanyi, J. M. Dille, and C. R. Linegar, Georgetown University Medical School, Washington, D. C.

Physicians will soon be able to use this new treatment in rescuing from death those who inadvertently or with suicidal intent take large doses of the barbiturate sleeping powders.—*Science Service.*

Diamond Finger Checks Car Cylinder Repairs

"BETTER than new" is the slogan of many reconditioners of automobile cylinders. Many conscientious garage mechanics almost reach such perfection, but some operators are turning out work which is far rougher than the original finish.

Unimpeachable evidence that this is the case has recently been gathered by the "profilograph," or roughness detector, developed by physicists of the University of Michigan Department of Engineering Research. A delicate diamond-pointed finger, moving over a supposedly smooth surface, traces, magnifies, and records irregularities which hitherto could not be satisfactorily measured.

Even on the mirror-smooth finishes of new cylinders the profilograph is sensitive

These huge tanks, each with a capacity of 32,000 gallons, are part of one of the largest hydrochloric acid storage units in the United States. The tanks are lined throughout with rubber, and their contents are withdrawn through a rubber-lined pipe system. An interior view of one of the tanks, taken before erection, is shown at the left. Note the size of the tank in comparison with the man at the far end.—*A.E.B.*

enough to trace slight hills and valleys, which are unimportant, however, in car operation. Some of the refinished jobs, on the other hand, show a traced profile resembling a side view of mountain peaks. Some reconditioned cylinders may approach new work in smoothness, states E. J. Abbott, research physicist, but many are much worse.

Motorists should require that reconditioned cylinders should not only be bored or ground to correct for wear, but the finish should also be restored by honing by competent mechanics, he states. A surface merely bored is left rough, which affects both initial and long-time wear, fit, oil consumption, and general motor depreciation. Instead of testing the finished surface merely by running the finger nail along it, the usual method, mechanics should have sections of cylinders of known degrees of smoothness for purposes of comparison. Even the finger nail test may be fairly efficient if such sections are always at hand, instead of depending on memories of previous finishes.

Chromium Plating Improved By New Method

ELECTRICITY can be "fooled" into following unusual lines by the addition of certain complicated organic chemicals to the bath in which metal articles are electroplated, with the result that much of the special apparatus now needed to apply the popular chromium plate may be discarded.

This discovery, saving much time and labor in chromium plating, and described as "the first real improvement in chromium handling since 1920," is reported by Dr. Richard Schneidewind, of the University of Michigan Department of Engineering Research.

Lightning, with its millions of volts, tends always to strike high and pointed objects. In the same way, the relatively low voltages flowing through an electroplating bath also are attracted to the raised and sharp-pointed parts of the object undergoing plating.

This means that the high parts of the object get the most current and, likewise, of the chromium or other metal which the current carries with it. The hollows and creases of the object receive less, often being left bare, in fact, unless special wires are arranged to conduct the current into these areas. This uneven spread is especially marked in the case of chromium.

The organic chemical which Dr. Schneidewind uses in the plating solution has the peculiar ability of "spreading" the electric current, so that instead of making a beeline for high spots, much more reaches into, and plates, the hollows. In engineering language, the chemical increases the metal "throwing" power of the solution. One manufacturer, for instance, found that he could increase his production of chromium plated frying pans from 65 to 100 an hour, largely because it was no longer necessary to take the time to fit the hollow of each pan with a special loop of wire.

Power-Driven Pruning Saw

A RECENT interesting development by the U. S. Forest Products Laboratory, Department of Agriculture, is a power-

A "long arm" for tree pruning

driven pole saw to be used in pruning operations. The Laboratory reports, however, that it is still in the experimental stage. "The power unit," says the *Log of the Laboratory*, "consists of a one-cylinder gasoline motor weighing about 60 pounds and mounted on a light drag. A 15-foot length of flexible shafting connects the motor to a pole unit. The pole itself is a hollow aluminum casing, inside of which a shaft revolves to drive at high speed the six-inch circular saw mounted at the top. The pole unit weighs about eight pounds and has an effective reach of 14 to 16 feet."

Food *Versus* Beauty

IN a good year, according to Dr. Edward L. Thorndike of Teachers College, Columbia University, Americans spend 17 billions of dollars on food, but only a little more than half that amount to satisfy hunger. Another 8 billions goes for clothing, but only 41 percent of that for actual protection against cold, heat, and wet.

About 700 millions are spent on cosmetics and beauty parlors. Of this amount, one seventh is for the pleasures of sight and smell, one fourth for the pleasures of sex and courtship, one third to gain general approval from others, one eighth to have inner self-approval, and about one tenth to secure mastery or domination in business or social life.

Searching for Oil Source

MAN is still seeking the origin of oil, industrial life-blood of today's machine age. Under the sponsorship of the American Petroleum Institute, national trade association of the petroleum industry, the search for oil sources begun several years ago is being continued with the cooperation of scientific organizations, domestic and foreign government bureaus, and individuals.

Scientific research is being employed in seeking the source of oil where once the "wildcatter," or oil prospector, gambled by drilling undeveloped territory. It is believed that with further progress it will be possible to ascertain not only the sources of

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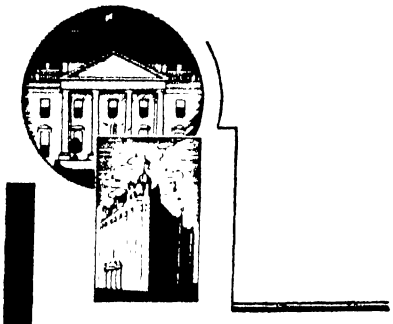

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oil, but also to determine in which regions the chance of discovering hidden subterranean oil pools is greatest.

In the light of present knowledge, structure, sand, and source are requisites to an oil pool. Productive pools have been found on poor structure, and even treacherous sand conditions have yielded substantially, yet many wells have been drilled where both structure and sand conditions were favorable, but oil was lacking. Deficient source now is believed to explain the failure of Tomball Field, on the Gulf Coast, of Wheeler Ridge Field, in California, and of other fields, to produce satisfactorily despite favorable indications.

The research work in oil sources is considered of vital importance not only in the search for new oil areas and fields, but also in connection with other studies, such as the migration of oil underground. While sporadic work has been done in studying migration, particularly as to how far and how rapidly oil can move through porous sands and rocks, definite conclusions cannot be reached until the origin of oil is known.

Under the direction of Dr. Parker D. Trask, of the U. S. Geological Survey, the Institute's research project began with a study of the oil-forming ability of the muds and sands of ocean bottoms. Virtually all known oil fields are in, or are associated with, rocks that once were such muds and sands. In this study Dr. Trask and those co-operating with him analyzed samples of mud and sand taken from the bottom of the Seven Seas.

The second stage of the work, now in progress, involves collecting and studying the formations associated with known oil fields, the knowledge gained in the first stage being applied in the second. While those engaged in the task say that possibly five years remain before thorough understanding is reached and the origin and sources of oil are known exactly, the work of the past three years steadily has narrowed the broad field of theories as to the origin of oil. Each newly-discovered fact has been a direction marker pointing the course of new research.

Results obtained already have proved useful, and the work is seen as entering the stage where each year's findings not only will add to man's knowledge of the origins and sources of oil, but will be of material aid in solving many of the petroleum industry's production problems.

Stainless Steel River Bed

In the construction of the dam at what is to be known as the Lady Bower Reservoir, situated some 10 or 12 miles from Sheffield, England, on the Sheffield to Manchester "Snake" road, an unusual type of bed has been constructed. The Derwent Valley Water Board has taken advantage of the use of "Staybrite" stainless steel for the laying of a "throat" between the dam and the continuance of the River Derwent, towards Bamford. The throat, as will be appreciated by water engineers, lies on two sides of the embankment, with a sort of hump between the flow in the two streams, and is completely lined with 18-gage sheets from two to four feet wide, rectangular in shape. The sheets are bent like trays about 1¼ inches deep which are set in concrete.

Use of this metal as a lining, or bed, enables the engineers to calibrate the flow of the water and to ensure also that the markings will always be discernible. The metal is polished and does not permit corrosion or accretion of moss and other vegetable growth which would interfere with the markings.

Steady Rise in Locomotive Tractive Power

Locomotives in service on Class I railways numbered approximately 48,300 at the end of 1934. There have been steady reductions in the number of locomotives ever since 1924.

These reductions have been made possible, in part, by the installation of new engines of greater power, and by more intensive locomotive utilization; the decline in traffic since 1929 has also been an important factor. The number of locomotives in service on Class I lines, together with the average tractive power per steam engine, is shown below.

Year	*Number of Locomotives*	*Average Tractive Power (Pounds)*
1916	61,332	33,188
1920	64,746	36,365
1921	64,949	36,935
1922	64,512	37,441
1923	65,327	39,177
1924	65,358	39,891
1925	63,974	40,666
1926	62,776	41,886
1927	61,363	42,798
1928	59,470	43,838
1929	57,571	44,801
1930	56,582	45,225
1931	55,149	45,764
1932	53,316	46,299
1933	50,903	46,916
1934	48,304	47,712

As stated, one of the reasons why the railways have been able to reduce the number of locomotives in service is that remarkable progress has been made in increasing the power of the average locomotive. From 1916 to 1934 the tractive power of the average steam locomotive has been raised from 33,188 pounds to 47,712 pounds, an increase of 44 percent. The 1934 figure represents the highest point yet attained.

Painless Dentistry

Dental patients received with much pleasure the recent news that Dr. LeRoy L. Hartman, Professor of Dentistry in the Columbia University School of Dental and Oral Surgery, has developed a chemical which would deaden the pain of drilling a decayed tooth. Dr. Hartman has not patented this invention, but instead has offered it as his contribution to the relief of unnecessary suffering. At a recent meeting in New York, Dr. Hartman made public for the first time the formula for his pain deadener, together with directions for its application. This information is quoted below:

Formula by weight:

Thymol	1¼ parts
Ethyl alcohol	1 part
Sulfuric ether	2 parts

Keep tightly corked in brown glass bottle. One-half ounce sufficient for 200 applications. Use cork or tin-lined stoppers only.

This is a topical application, made on a moistened pellet of cotton, not saturated, directly to the dentin or caries. If applied

over the caries, a second application may be necessary after the caries has been removed. Allow pellet to remain in contact one minute for children, 1½ minutes for adults. Remove pellet and apply blast of warm air to area of application. Use rubber dam.

If cotton rolls are used, varnish gums surrounding tooth and change cotton rolls immediately after application.

Rhodium and Rhenium Plating

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ORGANIZATION, AIMS AND ACTIVITIES OF THE HIGHWAY RESEARCH BOARD is a 16-page booklet published by the *Highway Research Board, National Research Council, 2101 Constitution Avenue, Washington, D. C. Gratis.*

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AERIAL FERTILIZATION OF WHEAT PLANTS WITH CARBON-DIOXIDE GAS, by Earl S. Johnston, covers the subject of this important agricultural work, giving the results of numerous experiments so far conducted, together with a summary and general conclusions. Illustrated with six photographs. (Publication 3346.) *Smithsonian Institution, Washington, D. C.—Gratis.*

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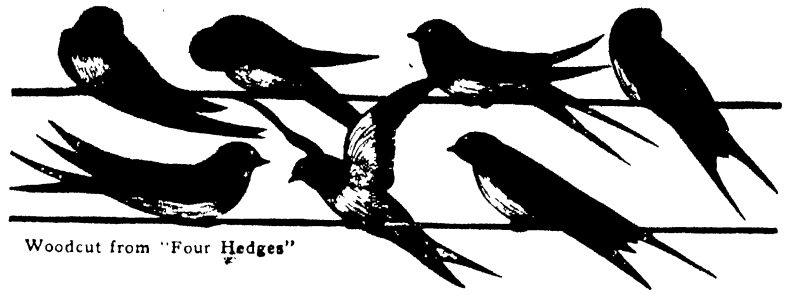

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COVER

SYMBOLICAL of the progress that has been made in air transport operations during the past few years is the striking photograph by Richard B. Hoit, reproduced on our cover this month. Ships of the China Clipper type have been making history over the Pacific, and as pointed out by Mr. Cleveland in his article starting on page 173 of this issue, we may look forward to the probability that aviation history will repeat itself in the Atlantic sector during the present year.

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50 Years Ago in . . .

Scientific American

(Condensed From Issues of April, 1886)

BACILLUS—"Dr. Cantani, of Naples, having in mind the fact that the bacillus of consumption is destroyed when other bacteria are grown in the same soil, has proposed to eradicate consumption by introducing into the system other bacilli which are injurious only to the germs of the disease. If an organ of the body be attacked by a bacillus dangerous to human life, he would introduce another, harmless to man but fatal to the destructive bacillus."

INDIAN MARKET—"A gentleman residing in Calcutta having seen our illustration and description of a separator for wheat in Scientific American, writes to this office a long and very interesting letter, giving important statistics relative to the growth and exporting of wheat from India, and suggests that it is a good market for meritorious inventions in the agricultural line, and especially the class pertaining to the cultivation and cleaning of wheat."

MILLS—"The cotton manufacture in 1885 shows the total number of mills in the United States as 826, containing 261,228 looms and 12,280,342 spindles, manufacturing 786,000,000 yards of print cloths per annum. Of these, New England has 481 mills, containing 205,011 looms and 9,481,272 spindles, manufacturing 646,000,000 yards of print cloth."

WATER WORKS—"The method of obtaining an additional supply of water for the city of Brooklyn, N. Y., by means of driven wells, has attracted widespread attention because of the originality and boldness of the plans and the perfect success attained. The pumping engines are provided with automatic cut-off valve gear of the most approved type, using steam pressure of 90 pounds per square inch. The steam cylinders are arranged on the cross-compound plan—that is to say, in each engine, the high pressure cylinder works one water pump and the low pressure cylinder works the other."

TIN—"A 9000-pound mass of tin ore was recently exhibited at a smelting works in New York. It was taken out of a 29-foot vein in the now well-known Etta tin mine, in the Black Hills."

BAGASSE—"The utilization in sugar making countries of the residual canes—bagasse—for fuel and gas making is an important practical problem which has yet been only partially solved. It is stated, however, in the *Revue Industrielle*, that M. Pellet has succeeded in devising a system of dealing with the material which produces, by direct compression, a combustible containing not more than 40 to 50 percent of water. In this state the waste can be burnt directly in boiler furnaces or carbonized without previous drying."

LIGHTHOUSES—"At the Society of Arts, on March 10, a lecture was delivered by Mr. E. Price Edwards 'On the Lighthouse Illumination Experiments at South Foreland.' The general results of these experiments were that while electric arc light was more absorbed in proportion than gas or oil light as it passed through fog, still its greater intensity enabled it to penetrate much farther than these. The Berlin core carbons of Messrs. Siemens were found to operate best, the core being of graphite."

SPRINKLERS—"It is about ten years since the first automatic sprinklers were introduced into factory buildings, and mainly, we imagine, through the earnest advocacy of the mutual insurance officials, they soon came into general use in such structures."

ASTRONOMICAL PHOTOGRAPHY—"As a few experiments in celestial photography tried last year by means of quite rudimentary instruments gave good results, the Director of the [Paris] Observatory has been pleased to authorize the construction of a special apparatus, which we illustrate herewith. This new instrument consists of two juxtaposed telescopes enclosed in an oblong rectangular metallic case, and separated through their entire length by a thin partition. One of the objectives, of 9½ inches aperture and 12¾ feet focal length, is designed for visual observation and serves as a finder. The other, of 11.4 inches aperture and 11¼ feet focus, is achromatized for chemical rays, and serves for photographing."

SACCHARIN—"Mr. Ivan Levinstein, the President of the Manchester Section of the Society of Chemical Industry, calls attention to a new substance which is extracted from coal tar, and possesses sweetening properties far stronger than the best cane or beet root sugar."

LIQUID CO_2—"A patent recently taken out proposes to produce carbon dioxide gas for liquefaction by having a solution of sodium bisulphate in a leaden container, and running into it some carbonate or bicarbonate, dissolved or suspended in water, the evolved carbon dioxide being drawn off over a drying mixture into a gasometer, from which it is drawn for liquefaction by compression."

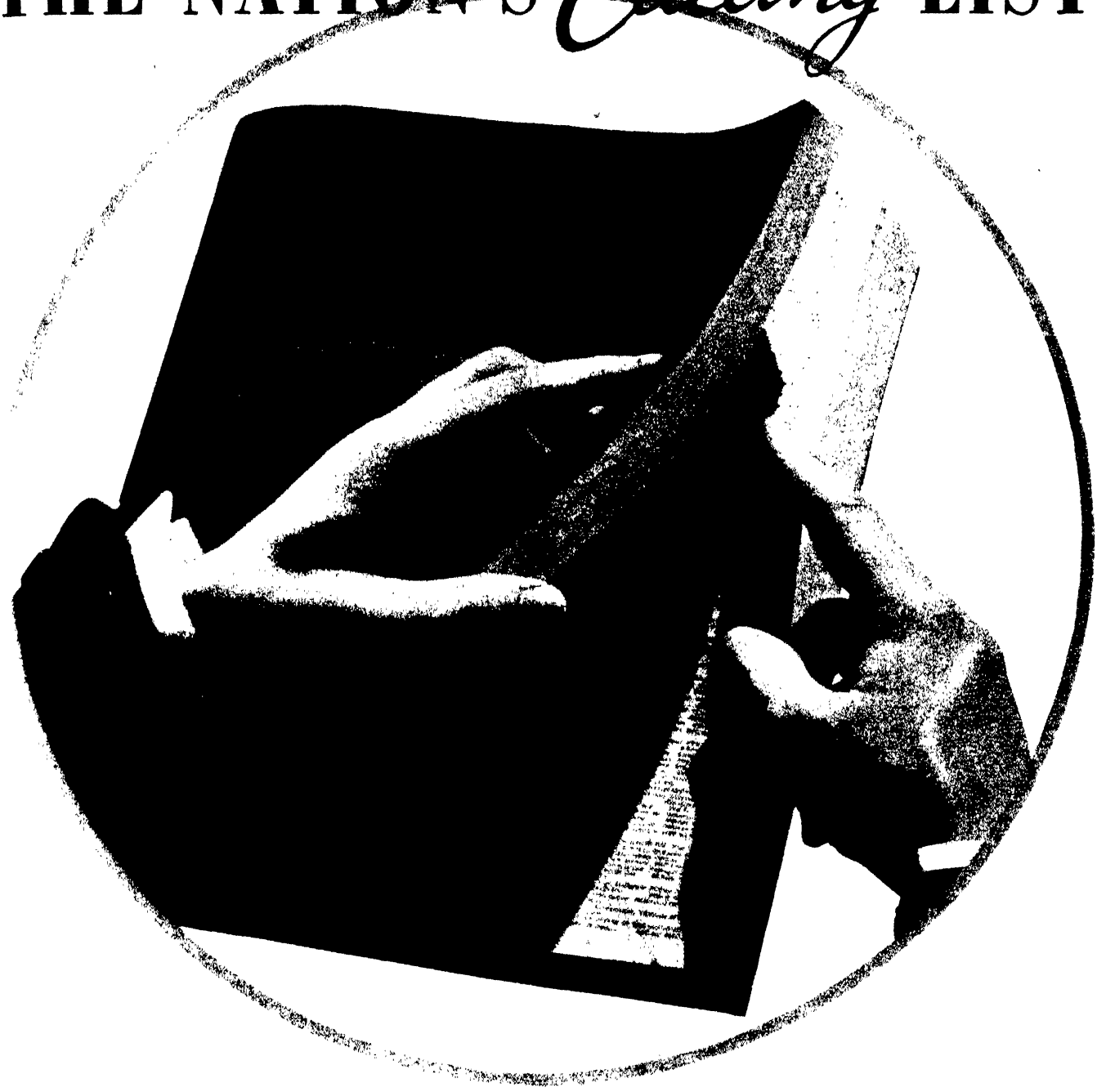
OIL—"The report that an artesian flow of petroleum had been discovered in the southern part of Santa Fe County, New Mexico, between the mining villages of Golden and Wallace, has been confirmed, and samples taken to the capital and tested. The oil flows through tubing 55 feet down, and the flow is reported to be copious and steady. The crude oil burns freely and with a good flame. Several claims have already been located in the neighborhood of the well."

STATUE OF LIBERTY—"The pedestal for Bartholdi's great statue has now been completed. The last piece of stone has been put in place, and the last of the large iron girders to which the statue will be fastened is ready for duty. When completed, the statue will look even grander at night than in the daytime, as its electric illumination will give the figure greater prominence. It is proposed to place four large lights at the base of the statue, one at each corner . . . and a powerful shaft light on the torch."

AND NOW FOR THE FUTURE

- **The Mystery of the Neutrino, by Jean Harrington**
- **What is Personality?**
- **Hatchery Trout as Active as Those in a Natural Environment**
- **Color Blindness and Strange Sensations**
- **Broadening the Port Facilities of Bordeaux, France, by R. G. Skerrett**

THE NATION'S *Calling* LIST



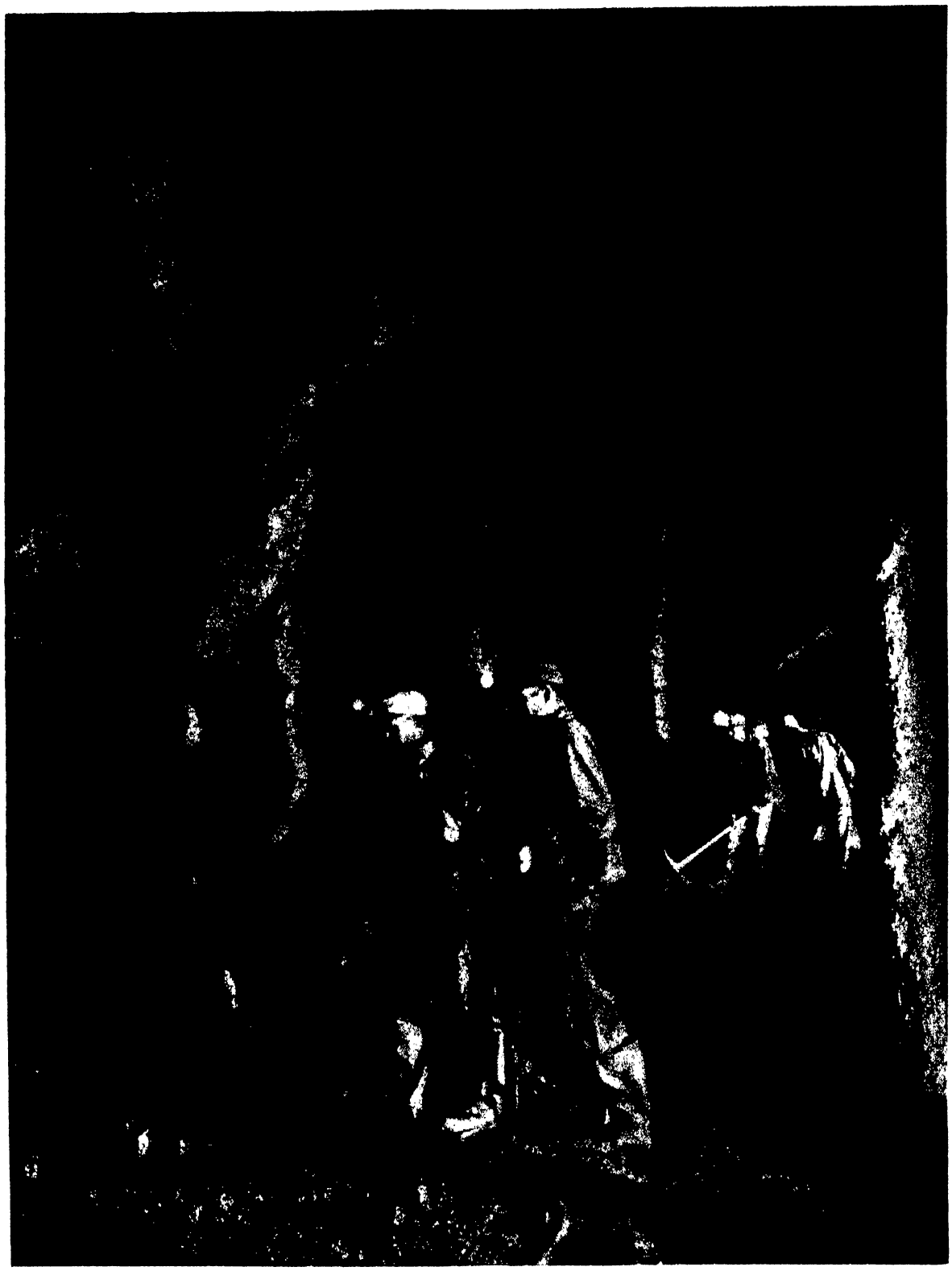
THE telephone directory is the nation's calling list. Millions of people refer to it daily—in homes and offices and in public pay stations. It is the busiest book—it plays a part in countless activities.

For the names in the telephone book are more than names. They are friendships and homes and families. They are bridge parties and golf games—business successes—buyers and sellers of wheat or pins or skyscrapers.

More than 12,000,000 names are listed in the directories of the operating companies of the Bell System. You can go straight to any one of these millions of people—easily, quickly and economically—by telephone.

The classified directory is an important feature of your telephone book. It is a handy, reliable buying guide —a quick, easy way to find "Where To Buy It."

BELL TELEPHONE SYSTEM



WAY DOWN UNDER IN A BAUXITE MINE

THINK of bauxite and you think of aluminum, the light metal that, in 50 years, has won such a definite place in our industrial world. But only about three quarters of all the bauxite mined goes into the manufacture of this useful metal. Large quantities are used by the abrasive and refractory industries; in making quick-hardening cement; in manufacturing aluminum chloride used in petroleum refining; and for making aluminum sulfate, which is largely used in paper making and in water purification. Bauxite is a widely distributed ore, being found in most countries of the world.

Photograph by Richard H. Holt

China Clipper, forerunner of giant planes that will soon span the Atlantic

AND NOW, THE ATLANTIC

One of the Last Areas to be Conquered By Commercial Air Transport . . . Technical Advances Have Outrun Political and Industrial Plans

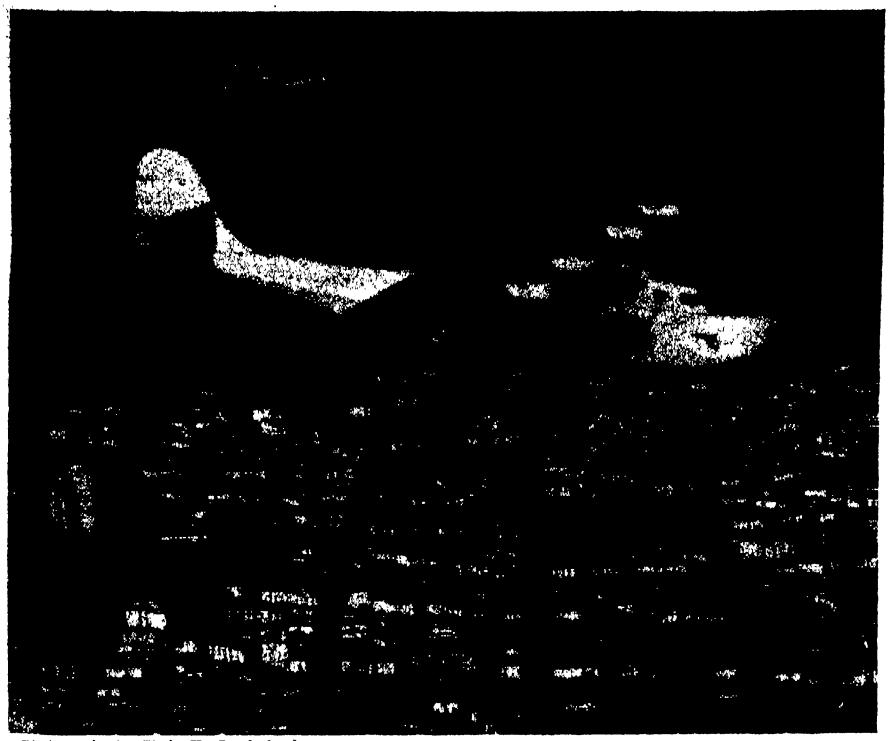
By REGINALD M. CLEVELAND

NEW YORK to London in 36 hours, with passengers, mail, and express! A decade ago this might well have been the title for a book by a contemporary Jules Verne. Today it is an imminent reality. The North Atlantic, scene of a score of heroic pioneer flights following that first solo blazing of its trail by Colonel Charles A. Lindbergh in May, 1927, which may be said to have touched off the fuse of air transport development the world over, is to become, almost certainly this year, the field of scheduled operation.

This area of uncertain skies and an often troubled sea, one of the last to remain free from the shadow of commercial wings, could be flown today with American equipment, produced in American factories and operated by American airline companies. It presents a contradiction to the other major fields of air transport development in that technical advancement here has outrun political and industrial planning.

In the case of the great international system of air lines grouped under the aegis of Pan American Airways, which circle the Caribbean and run almost the whole perimeter of South America and which extend over Alaska and form a growing network in China, the plan came first; the equipment was developed to suit the exigencies of the plan. The same holds true of the longer tentacles of the European airlines; of Imperial Airways' Empire routes, running down the spine of Africa to Capetown and stretching, first to Karachi, then to Singapore and finally across the Timor Sea to Australia; of the East Indian route of the Royal Dutch Airlines, K.L.M., linking Amsterdam with Batavia and Surabaya; of the French line, spun out by Air France to Indo-China.

Across the South Atlantic, again, the services of Air France and of Lufthansa have followed the development of a commercial demand. And in the most recent and, in many ways the most spectacular, of the extensions of the air-transport web, the 8900-mile line of Pan American joining California with China across the Pacific, the establishment of an airway and the development of air-borne vehicles to fly it, have followed upon carefully considered political and economic



Photographs by Clyde H. Sunderland

Two views of *China Clipper*, flying boat that has made aviation history in the transpacific air service, and from which valuable lessons have been learned

groundwork, carried to a logical end.

In the case of the North Atlantic, however, the picture has been reversed; the anomaly is presented of the perfection of flying equipment fully equal to the task while perhaps the most important transoceanic route of all remains unflown as international agreements are perfected.

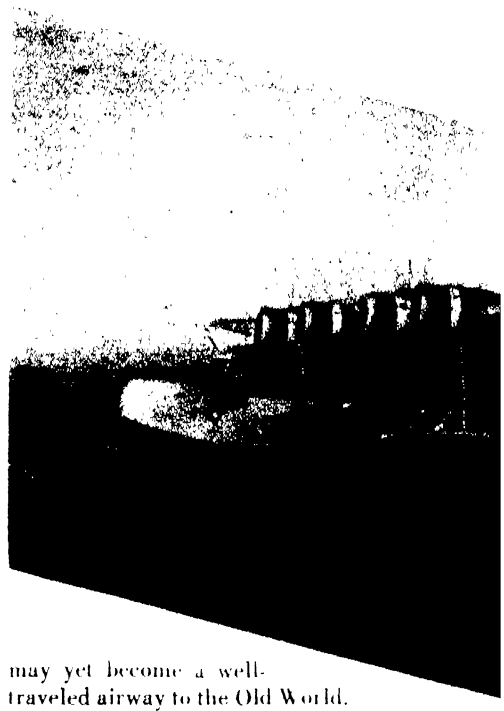
WITHIN recent months, however, these agreements have advanced from a stage of friendly discussion to one of assured commitment. The United States Post Office Department has announced that transatlantic mails will be flown; the State Department has made it plain that it will co-operate with other nations in what, due to the nature of the terrain and bases, must be an international undertaking. Beyond this, representatives of the British Government, the Canadian Government, and the Government of the Irish Free State, have met with our own Interdepartmental Committee for Civil Aviation, and with representatives of Pan American Airways, which does and must hold a key position in the undertaking, to reach definite conclusions.

These conclusions are that the North Atlantic will be flown with mail and passenger traffic must inevitably shortly follow—on optional routes depending on weather conditions, both seasonal and temporary, which roughly lay down an irregular quadrilateral course across the ocean. The southern and longer route extends from the United States either at New York or a point south of Washington—a matter which has not yet been fully determined—by way of Bermuda and the Azores. The northern extends from the same American base to Newfoundland and thence by a great-circle route to Ireland. The longest over-water hop in either route does not exceed 2000 miles.

Already in the Pacific, the great Clipper ships of Pan American, first the Sikorsky *S-42* as a test plane, and more recently the Martin flying boats, *China Clipper*, *Philippine Clipper*, and *Hawaiian Clipper*, have demonstrated beyond peradventure that they can negotiate a longer stretch—the 2410 miles run from Alameda to Honolulu—with an ample margin of fuel for safety. The Pacific is proving a laboratory for the Atlantic, just as the Caribbean has been for half a dozen years a laboratory for the Pacific operation. There planes have been tested, radio aids have been developed, and men have been trained in preparation for the complex and exacting business of transocean flying.

ANOTHER laboratory is being used with an eye to the Atlantic, and this is the Territory of Alaska. There, although it is overland operation, many of the problems are encountered which must be solved on the third North Atlantic route, which has long been discussed, but for the present is being held in abeyance. This is the so-called northern island route running from Newfoundland or Nova Scotia to Labrador, Greenland, Iceland, and the Faroes. It is a route of short hops, with over water stretches which, as far as range is concerned, are mere child's play as compared with the wide reaches of the Pacific. But it is a route of fog, of ice, of changing conditions of terrain, from the comparatively simple Newfoundland area to the Greenland ice-cap, and, especially, it is a route long stretches of which often lie in the most unfavorable temperature zone, that in which wings and propellers ice up through the combination of dampness with the right degree of cold.

All these conditions are also found on the Alaskan mainland and there Pan American is constantly testing planes, men, and engines with a view to throwing new light on the operation of the route to Asia which Colonel and Mrs. Lindbergh surveyed for it three years ago. With better knowledge, and especially with more complete meteorological information, it may yet become a well-traveled airway to the Old World.



Could one of the 25-ton *Clippers* of the Pacific service be diverted tomorrow to the Atlantic, there is no question that it could make the run, either by way of Newfoundland and Ireland or by way of Bermuda and the Azores, cruising steadily at 150 miles an hour with 16 passengers, a crew of seven, and a ton of mail or cargo, and thus link the Old World and the New on a schedule well within the limit indicated at the opening of this article. But there is something else to consider besides the question of technical efficiency.

Great Britain and her Dominions beyond the seas control the ports which are needed as bases for any successful transatlantic service in the present state of the art. When the sub-stratosphere plane has arrived, flying at perhaps 20,000 to 25,000 feet with sealed cabins supplied with oxygen and cruising, in the thinner airs, at 250 or more miles an hour, intermediate bases will lose their importance.

Such planes are coming, perhaps sooner than is generally expected. Lead-

ing designers of large aircraft, including Igor I. Sikorsky and Glenn L. Martin, have both predicted flying boats much larger than the current giants of the Pacific within a relatively short time. Both have plans prepared for ships of twice the capacity of the largest present *Clippers*. Mr. Sikorsky especially leans towards the advantages of high-altitude operation.

But for the present—and the Atlantic is to be conquered in the year 1936—bases are important to any scheduled operation which must be predicated on the ability, not merely to get across, but to get across with a payload which will offer some inducement for a venture of so pioneering a character. The far-seeing gentlemen who are at the helms of Pan American and Imperial Airways have long understood this situation, and have been in full agreement upon it.

Now, with the participation of Canadian and Irish Free State authorities, and with the whole-hearted encouragement of both the

American and the British postal authorities, these understandings have developed into overt agreements. And Pan American, with the equipment and the experience, and Imperial, with the bases and with what may be expected to be very comfortable and reliable equipment building for completion late this year, will operate the North Atlantic service together.

They will not be alone, however, from all present indications. The French, the Germans and the Dutch all have their eye upon an Atlantic service. Air France has developed and flown a very large and apparently quite efficient airplane, the Latécoere flying boat, *Lieutenant De Vaiseau Paris*. This six-engined giant, with upper and lower decks and a gross weight of 70,000 pounds, has already crossed the South Atlantic on its line's route between Africa and Brazil, flown up the South American coast to the French colony in Martinique, and thence over a stretch of nearly 2000 miles to Pensacola, Florida. That it turned turtle while at anchor in the harbor in a sudden tropical storm was really no fault of the airplane. The ship, while not fast in the sense of the American *Clippers*, can carry a heavy load for a long range, and the French have other big boats building.

By the time this is in print, French and German missions will have visited Washington to discuss the Atlantic problem. It is already clear from the position taken by the State Department that they will be met in a co-operative spirit.

THE Lufthansa, which already operates an extraordinarily successful and expeditious mail service across the South Atlantic, using Dornier Wal flying boats which it catapults from mother ships at Bathurst and Natal, has already conferred both with Washington and with Pan American executives in the person of its managing director, Mr. Martin Wronsky. It is his opinion that there is enough mail business by air in the North Atlantic for all comers, and he said unequivocally while here that his company would at least conduct experimental flights of the type which are being operated in the South Atlantic.

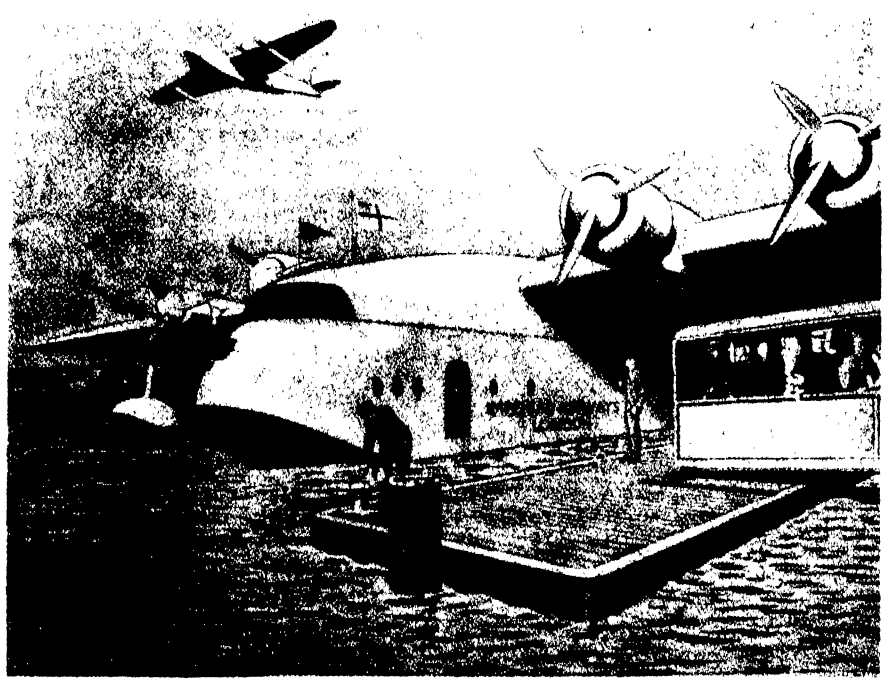
He is not a believer in very large flying boats for passenger service, however. His company has an interest in the Luftschiffbau Zeppelin. He holds that giant airships, such as the *LZ-129*, which will make its first transocean flights this spring, offer the solution for passenger air travel between the United States and Europe. It seems safe to predict that this huge ship, with cabins for 50 passengers, promenade decks, and all the comforts of home, having a cruising speed of 78 miles an hour and a range of more than 8000 miles, will make some round trips over the North Atlantic before its heavier-than-air competitors get under way.

There are not a few experts who agree with Herr Wronsky that the machine-like operation of the veteran *Graf Zeppelin*, shuttling back and forth between Friedrichshafen and Pernambuco, with all the regularity of a limited train, has given good grounds to believe that the airship, properly constructed and manned, is a highly satisfactory solution for transocean travel. They point, too, to the great lift, range, and roominess of this type of vessel, especially in such sizes as the new German ship, to support their theses.

BUT in the air, at least, the race is nearly always to the swift. The magnificent performance of America's aerial *Clipper* ships, reenacting in the Pacific the pulse-quickening drama played a century ago by the merchantmen Clippers in the China trade, leaves little room for doubt that whether giant airships also link the United States and Europe, great wings, supporting the clean hulls of flying boats, will likewise ply the North Atlantic air lanes and bring New York and London little more than a day apart.

●

Additional data pertaining to the foregoing article will be found in the following issues of Scientific American: Atlantic flight, February 1934; The Clippers, July 1934, December 1934, and March 1935; LZ-129, June 1934 and June 1935.—The Editor.



An artist's drawing of a British flying boat now under construction, for possible transatlantic use, by Short Brothers (Rochester and Bedford) Ltd.

Bridge Builder
Lawyer
Manufacturer
} Astronomers

"THEY are amateurs who have done some fine work in developing precision telescope drives, and making motion pictures of heavenly bodies, that make professionals green with envy." This is how one professional telescope designer recently spoke of the amateur-professional astronomical work of three citizens of Detroit, whose photograph and whose observatory and newly constructed solar tower are shown on this page.

The triumvirate which is responsible for the McMath-Hulbert Observatory of Michigan University. *Left to right:* Francis C. McMath, builder of bridges, Judge Henry S. Hulbert, lawyer and banker, Robert R. McMath, maker of stampings

Not only have these three amateurs, by sheer merit, crossed over into practically professional astronomical status and been accepted as such, but so has their observatory, which is now a part of the University of Michigan. The three who staff the McMath-Hulbert Observatory are Francis C. McMath, a retired bridge builder, whose biggest single piece of work was the Quebec Bridge, Henry S. Hulbert, a former Senior Judge of Probate in Detroit, now vice-president in charge of trusts in the National Bank of Detroit, and Robert R. McMath, a former World War major in the Aviation Section of the Signal Corps who is now president of the Motors Metal Manufacturing Company, makers of heavy motor stampings. Robert R. McMath has done most of the work on the observatory, and is its director. Prof. Heber D. Curtis, head of the Department of Astronomy at the University of Michigan, himself a fine mechanic, states that Mr. McMath is rapidly becoming a professional astronomer and is a mechanical genius. The McMath-Hulbert Observatory is at Lake Angelus, Pontiac, 50 miles north of Ann Arbor, Michigan.

In the photograph two observatory domes are seen. The low one on the right was built several years ago and houses a 10½-inch reflecting telescope with which four notable motion picture reels were taken (of these many hundreds of copies have been sold, at no profit to the observatory). These showed respectively the occultation of the moon, the eclipse of August, 1932, star fields and the motions of Jupiter's satellites, and the famous "solar bomb" of June 19, 1934.

THE last of these motion pictures were taken with an instrument about five feet long, having a name somewhat longer, attached to the telescope. This is the spectroheliokinematograph, a decipedalian name which is perfectly digestible if one can find the joints when carving it. "Essentially," Robert McMath writes, "this instrument is a spectroheliograph plus a motion picture camera and, as is well known, such an instrument makes it possible to photograph solar phenomena in the light of some chosen wavelength or single element. The addition of the motion picture camera has made it possible, for the first time, to secure continuous records of solar phenomena. On June 19th, 1934, we were fortunate enough to photograph, in the light of the red alpha line of hydrogen, a rather large eruption from a sun-spot. This film gives a continuous record of the ejection of a large cloud of hydrogen gas, or a 'solar bomb' 19,000 by 40,000 miles in dimension, at the rate of 40 miles per second from a sun-spot, and the subsequent sucking back of some of the cloud into the spot again; the total life of this interesting outburst was of the order of only ten minutes. This picture convinced us that more elaborate equipment was needed in order to carry on the solar work. Ground was broken in July, 1935, for the new solar tower and we hope to be in actual operation by the first of May, 1936."

The solar tower just mentioned by Robert McMath is the higher dome at the left, in the same picture. The two solar towers which are at the Mt. Wilson Observatory are already familiar to all. The solar tower at Potsdam, Germany (often called the "Einstein" Tower because some work on relativity was once done on it), is often shown in photographs, and there is a similar tower at Tokyo. Likewise there is a solar tower at Arcetri, near Florence, Italy. The McMath-Hulbert tower will be the world's sixth, but it will be the most efficient of all, and between the longitudes of California and Italy it will be the only watchman of the sun as the earth rotates. The aim of astronomers is to keep an eye on the sun all of the time, and this of course means providing enough solar observatories geographically distributed so that one of them is always under the sun.

The whole observatory will permit astronomers to learn more about the solar surface—largely an untouched field.

More technical details regarding the McMath-Hulbert Observatory will be found in the department (page 214) which is each month devoted to those of our readers—about 25 percent—who regularly follow the hobby of amateur telescope making.

The McMath-Hulbert Observatory at Pontiac

OUR POINT OF VIEW

Build Airships?

THREE dirigible airships, built in this country, all were wrecked. After the last, the *Macon*, dropped into the sea, there was a widespread demand that we abandon such lighter-than-air craft. In view of the experience of other nations, this demand seemed logical and, as a consequence, the airship enthusiasts have had but a small following the past year or two.

But wait . . . Germany has had one success after the other with her dirigibles. There is the notable example of the *Graf Zeppelin* which is now several years old. She has encircled the globe, flown the North Atlantic, and is now and has been for a year or two engaged in a regular, scheduled service to and fro across the South Atlantic. Another example is the American *Los Angeles*, veteran of the air lanes which was built in Germany and is now retired, the first and only dirigible airship to "die of old age."

Perhaps, then, the dirigible airship principle is not one to be so lightly cast aside. That has been the opinion of many who believe that no possibility should be overlooked in man's stride onward to new scientific triumphs, and that the relatively small toll of any one development should never cause abandonment of further research. After all, no achievement of man has been without its early disasters and its roster of human victims —all forms of transportation, for example—yet, hitherto, each disaster has but spurred research anew. The dirigible airship constitutes another form of transportation, and it may—or may not—have very great potentialities for the future in both commercial peace-time operation and in case of war.

We should not, therefore, condemn the dirigible on the record of a dozen disasters, ghastly though some of them have been, but should heed the advice of those leading scientists on the Science Advisory Board which was named March, 1935 by Secretary of the Navy Swanson, and which numbers among its members: C. F. Kettering, R. A. Millikan, and Frank B. Jewett. This board favors a program of construction for the Navy of large dirigibles. Their thought is that these craft may prove very valuable, and it is for studying their possibilities that new ships should be built. The first built under this program should, the scientists say, be used not as an adjunct to the fleet but as a "flying laboratory" in which might be studied further those questions and problems which were but partially solved in our operation of ships that crashed and the now-retired *Los Angeles*.

It is rather astonishing to us that the country had to ask for such an opinion from scientists, but we will be disappointed, disgusted, if their suggestions are not carried out. Science has never been a weakling to confess defeat in the face of obstacles!

Amateur Missionaries of Science

IN the State of Nebraska it is no longer legal for commercial collectors to dig for prehistoric relics, for the legislature of that state has given the State Geological Survey police power to regulate and control the search for fossils and Indian artifacts. Other states might well copy this kind of ruling from a state which is resolved thus to guard its rich sources of undiscovered scientific data from the irresponsible.

Those few pot hunters who oppose such an invasion of individual liberty—and such it frankly is—are perhaps not so fundamentally wanton as some have asserted. They do not collect and deal in "Indian arrowheads" and similar "souvenirs" because of any scorn of science, but simply because they do not fully sense what it is that they do. They need, therefore, not so often the toe of a boot as friendly instruction in the significance and purpose of science. Might it not then be one of the functions of amateur archeologists to attempt, by the most diplomatic of methods, gradually to convert such collectors into comprehending amateur archeologists, even at the expense of much time and probable initial rebuff? This, rather than the passage of any kind of mandatory law, is the one method which is ever likely in this country to accomplish the desired result, since it is so easy in the big open spaces to defy the law and bootleg the relics of the ancient past. Let every person of scientific learning appoint himself a committee of one as a missionary to make such conversions, for there are not enough professional scientists to accomplish the desired end.

In our rocks and soil there is only one set of evidences of earlier life. It behooves us to deal carefully with them, for when they are gone nothing on earth can replace them. Ancient artifacts and fossils removed from the site and strata of their discovery without scientific record are practically meaningless to science, since they do not relate to its structure as a whole. In a generation or two they find their way to destruction. It is a good thing that Nebraska is staying the hand of the unthinking commercial collector.

Atlantic Flight

AT the time of going to press, it appears that the long anticipated and much talked about conquest of the North Atlantic is soon to be accomplished. As pointed out by Mr. Reginald M. Cleveland, in his article on page 173 of this issue, the lessons that have already been learned through operations on the Pacific airline are being applied in preparation for scheduled Atlantic flights with mail and express, and finally with passengers. In this connection, it is essential that due credit be given to the brilliant and daring minds that, having formulated the plans, are pushing them to completion. To Pan-American Airlines, to Igor Sikorsky, to Glenn Martin, and to the many unnamed engineers and technicians who have given so freely of their energy and genius—congratulations and happy landings.

But transatlantic flight is more than a technical triumph, more than an engineering feat of great magnitude. It opens new avenues for world trade and world peace. As hinted by Mr. Cleveland, successful schedules over the North Atlantic presuppose complete co-operation between the nations directly affected. That the United States is aggressively taking the lead is to be expected, in the light of past accomplishment. That other nations will make strong bids for business is likewise to be expected.

It thus becomes apparent that aeronautical engineers cannot afford to rest on their laurels, content with accomplishment. Peaceful battles will be waged on the airlines, battles that will be won only by those with vision who press ever onward to conquer the impossible. Scientific research has shown the way to higher speed in transport planes, greater comfort and safety for passengers, increased economy of operation; it must continue to improve on all these phases. The foundations have been laid for world-wide airlines that will affect the lives of every civilized person. Upon these foundations must be built a structure strong enough to resist the assaults of international politics and petty nationalistic squabbles. With level-headed business men at the helm, guided by research engineers, we are sure that it can be done.

Bone Surgery With

Grafting Bones is Much Like Grafting Trees . . . Bone from Your Own Body . . . Cut with a Circular Saw . . . Shaped on the Spot with a Bone Mill

By FRED H. ALBEE, M.D., F.A.C.S.
Formerly Professor of Orthopedic Surgery at Columbia University. Consulting Surgeon to the Broad Street, Lutheran Hospital and other hospitals, New York
Founder of the Florida Medical Center, Venice, Florida

BY good fortune we are able to present, on the accompanying pages, an article by a noted, internationally-known bone surgeon, thus giving the lay reader a first-hand insight into a branch of surgery of the most modern and most romantic variety—the repair of damaged bones by means of living bone substance taken from the patient's own body. The author of the article became widely known at the time of the World War, first through six months of operation and demonstration in France, and later in America where he performed reconstructive operations on more than 2000 wounded American soldiers. Dr. Albee is an ex-president of the American Orthopedic Association, and a founder of the International Society of Orthopedic Surgery. He is the author of a large textbook which is widely used by surgeons, entitled "Orthopedic and Reconstruction Surgery," and he has been widely honored within his profession and without.

Bone surgery with metal plates or wire, or with pieces of hard and non-living bone, has long been familiar, but Nature often rejects such foreign substances. To repair living bone, living bone is an ideal material. Many of us think of bone as hard, dry, brittle and somewhat metallic, because most of us see it in that form. But our bones are really alive; they contain pulsating blood vessels and other living equipment. Such bone, rapidly removed from one place (often the convenient shin) and transplanted to another after accurate shaping, unites and grows to

THE origin of grafting of living cells, if recorded at all, is so obscure that I have not been able to trace it. I was not unfamiliar with the process in fruit-trees before I undertook to apply the principles to the surgery of bones. As might be expected, I found much in the study of plant grafting to guide me in bone-grafting. One can safely assume that the principles of plant grafting cannot be violated in the grafting of tissues of a higher form, and that grafting of bone cannot be as readily carried out as grafting of vegetable material.

These postulates arise from the very nature of biological principles and the decrease in adaptability with increase in specialization of tissue. There are three inviolable rules in plant-grafting; the tissues must be applied like to like, the contact must be most intimate, and they must be immobilized in that position. These principles are important in bone-grafting. Moreover, in the more highly specialized animal tissue it is desirable, if not essential, that the graft be autogenous; that is, come from the same individual.

When, in plant grafting, the bark and bud are removed for the scion, a piece of bark of the same size and shape is removed from the host (Figure 1), so that like tissues of the scion will be applied intimately to like tissues of the host and so that immobilization will be facilitated, as well as the early and profuse vegetable circulation from host to graft. Interruption of the circulation of sap in the host is thus minimized.

It is thus evident that the cells of the scion preserve their vegetative and proliferative power. The re-establishment of the circulation is simpler in the plant, but it is obvious that the sap must permeate the cells of the scion, or else the latter will eventually die. In bone, the re-establishment of circulation becomes a problem the solution of which governs the whole question of surgical technique.

IN the plant, as in bone, like tissues are applied to like, because there is a force called by John Hunter the "stimulus of incompleteness," which tends to force tissues to complete a broken surface, and because this force is greater when it is mutual—that is to say, when it is applied to two broken surfaces of like tissue.

Of all the layers in a tree—alburnum, heart-wood, and heart—the alburnum is the important one in grafting, since it is the proliferation of its cells in scion and host that brings about the union. In bone, and especially in long bones, the structure is much harder and more complex, and all the layers — periosteum, cortex, endosteum and marrow — take part, to a greater or less extent, in union. It is for this reason, and the extreme hardness and brittleness of cortical bone (the hard portion), that accurate, power-driven instruments are necessary for preparing graft and graft-bed. Perfect coaptation, so essential to the nourishment of the graft and to its function as a vessel-conducting and osteogenetic or bone-forming unit, can be attained in no other way. If conditions were similar, power-driven tools would be necessary for grafting in the vegetable kingdom as well, in addition to the necessity for doing the work quickly. This last is an additional reason for employing motor-driven tools.

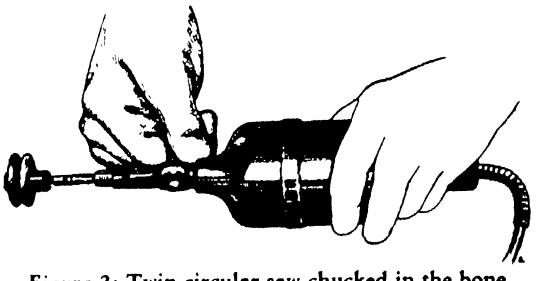


Figure 2: Twin circular saw chucked in the bone mill, held by the surgeon as in cutting an inlay from the shin bone or other available bone

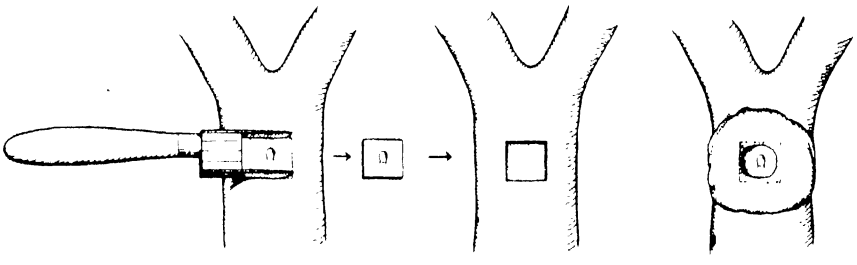


Figure 1: Left: Removing bark and bud with the double-bladed knife. *Center:* The bark removed from the host. *Right:* The finished graft, with paraffin

In plant grafting immobilization is effected in two ways, in addition to the

MACHINE TOOLS

the normal shape of the replaced bone, while the other fills out.

Recently we saw an operation of this kind, in color motion pictures, performed on a tubercular knee joint. With such speed that it seemed like opening a "zipper," the joint was completely exposed and the damaged bone was sawed away from the under side of the knee cap and the joint itself. Loss of the articulation then made necessary the rigid union of the upper and lower parts of the leg, and to accomplish this, two bone dowels were inserted, reaching through the top of the tibia and into the bottom of the femur. First the necessary holes were quickly made by means of twist drills and the bone mill—the patient, under total anaesthesia, being entirely unaware of the fascinating proceeding. Next, the two dowels had to be obtained and shaped. The shin bone was quickly exposed, with scarcely any bleeding, thanks to a tourniquet at the thigh. With the bone mill a pencil of bone about ½ of an inch square and eight inches long was quickly removed and cut in two. These pieces were rapidly fed into the bone mill, emerging as two neat, round dowels, which were then driven into the prepared holes. With no delay whatever the knee and leg were next flooded with antiseptic and closed.

The outstanding impression left by this spectacle was the speed and certainty with which skilled hands performed it. To perform work like this the surgeon must possess the mechanic's sure instincts for close, accurate work.—*The Editor.*

fixation provided by the accurate fit of the scion: the site of grafting is either bound with many layers of fabric or is covered with wax, or better, paraffin. These sealing substances serve as a sterile dressing as well, since they keep out fungi. If paraffin is used, immobilization is just as secure, and light—especially the ultra-violet—is allowed to penetrate to the wounded tissues and especially to the bud, which needs the ultra-violet for the metabolic activity of its chlorophyl.

I do not know the history of the double-bladed knife (Figure 1) which is used for plant-grafting, to ensure identity in size and shape of graft and graft-bed. I first saw it many years after I had designed the twin saw for bone grafting. Its use was demonstrated to me by the late Mr. W. J. Krome, in his citrus grove in Florida. Mr. Krome, after many years as a distinguished engineer, during which he supervised the construction of the Florida East Coast Railway in Key West, retired to indulge his interest in biology.

I did not design my twin saw (Figure 2) from this twin knife, but they were equally a response to the mechano-bio-physiological demands of the problem. The twin saws may be regarded as a cutting calipers, since they ensure that the graft will accurately fit the graft-bed.

Plant-grafting and bone-grafting thus have the same objectives and are carried out according to the same fundamental principles. In the plant the only force to be counteracted is that of the wind, and this only when the scion is of large diameter such as in the case of apple-trees. In bones, there is the pull of muscles, both involuntary and voluntary, and the exaggeration of the former by reflex from pain. Fixation and immobilization therefore present difficulties which must be met in a special way. It is necessary to consider bone, therefore, not only as a living tissue with an intricate circulation and metabolic function, but as a rigid piece of material which must be held in place with complete immobilization.

Union of graft with host, however much it may be affected by mechanical exactness, is dependent on the principles

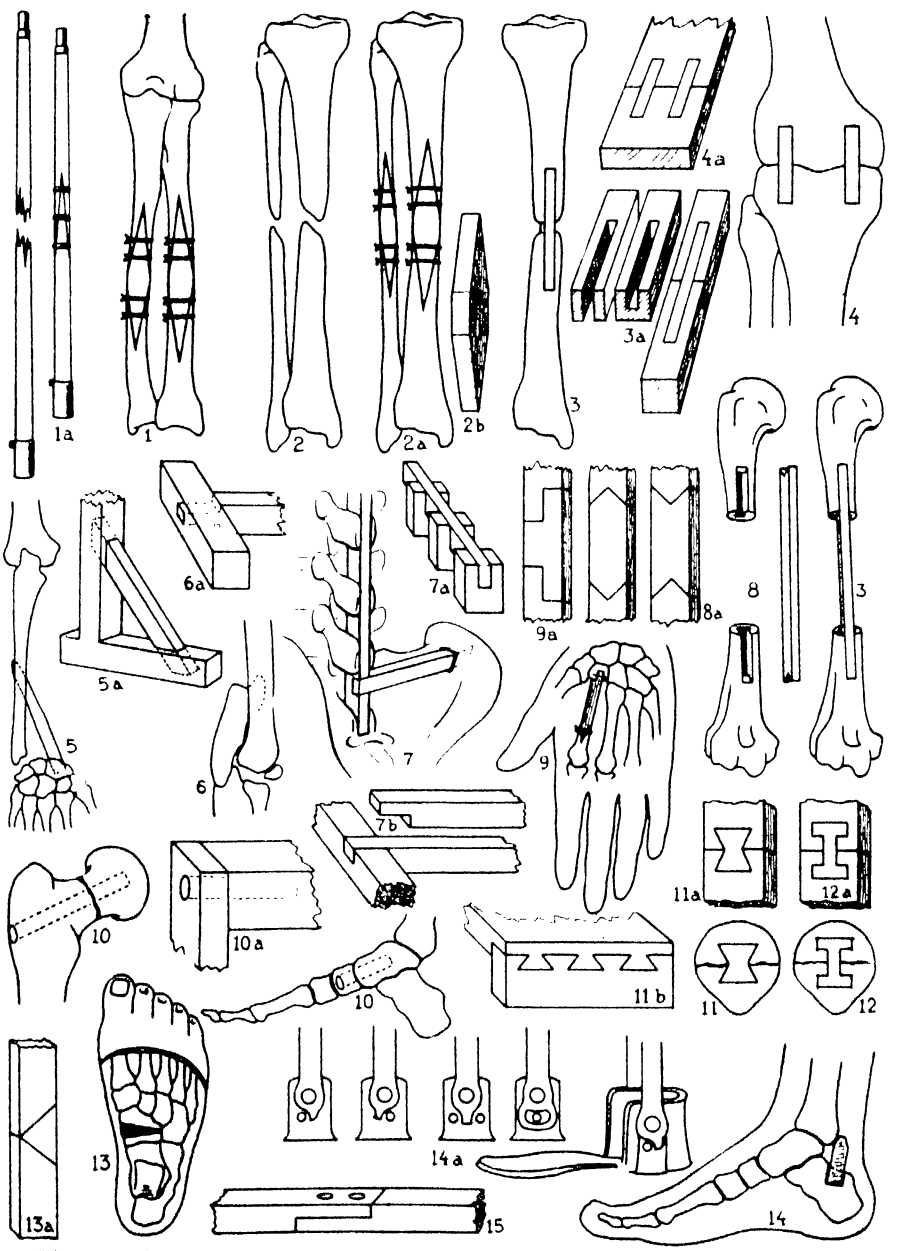


Figure 3: **The fine joinery element in bone surgery—a group of self-evident analogies. Numbers 11 and 12 are keyed-in tension members in broken knee caps which will not join. No. 14 is a stop, made of the patient's own bone, to prevent the foot from dropping. No. 14a is the analogy—a brace made of metal. The bone surgeon must first of all be a born mechanic having marked aptitude**

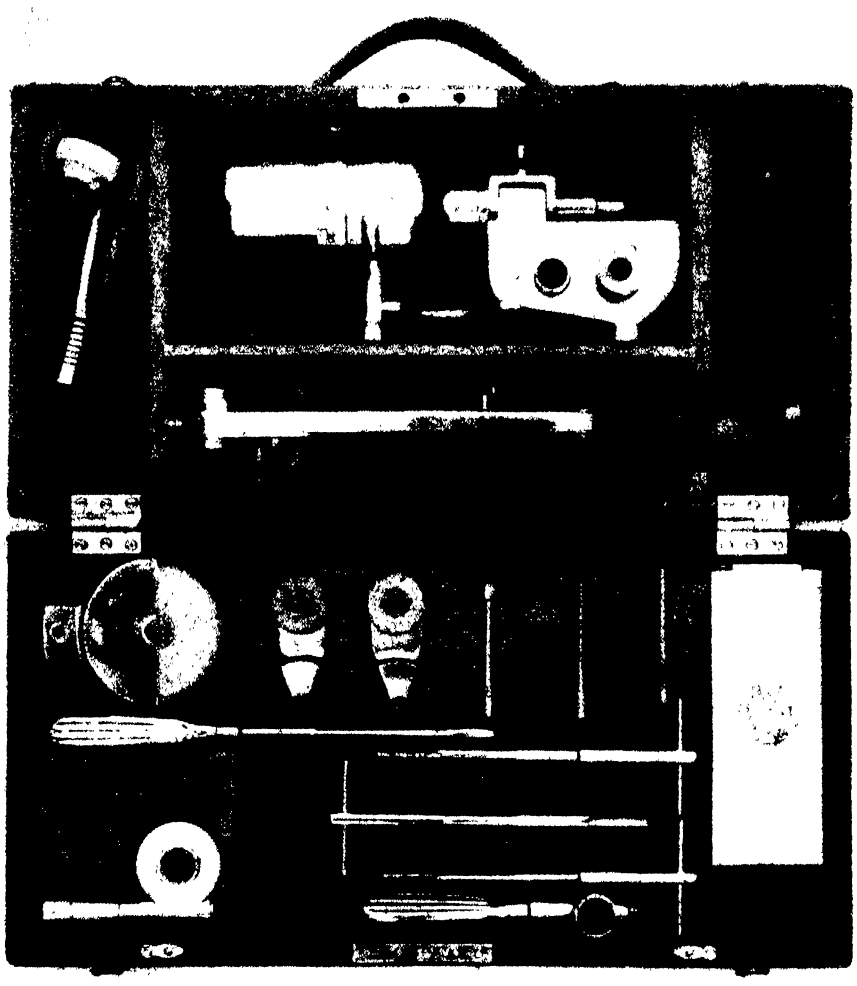


Figure 4: **The bone mill (shown at top of the picture) in its carrying case, with its accessories. Here the apparatus shown in Figure 2 is attached to a base. This converts the hand mill into a fixed lathe, when needed thus. Note chocks on side, for tools used in shaping bone dowel pins at the operating table. In lower half are circular saws, also taps for tapping out holes in patient's bones to receive threaded bone pegs, as shown in Figure 6, at F′**

of biology and physiology that govern the transplantation of tissue as a living, functioning structure. The graft lives if it is supplied sufficiently early and in quantity with blood from the host. Bony union with the host follows in the same way as it does after fracture, by a tissue bridge containing the first deposition of soft callus (soft bone material which is poured out, hardens and unites the bone) and then its impregnation with lime salts.

The graft, having been applied in a way most likely to favor its union with the host, is then influenced by those mysterious processes by which the graft remakes its structure, alters its shape and takes on added volume and strength, in order to accommodate itself to the demands of its new environment. That is, a graft of the general size of a lead pencil, and of any shaped cross-section, when implanted to take the place of a portion of the thigh bone, will take on the characteristics of the thigh bone shaft in every respect; that is, as to strength, size and shape of cross-section, external contour and internal architecture—it will even develop a marrow cavity.

For help with the mechanical problem, one must go to the joiner and study his various forms of mortise and how he selects each according to the mechanical demands of the situation (Figure 3).

My first application of the bone-graft was to the spine in Pott's disease. Since then, it has been used in grafting most of the bones in the body and for a variety of purposes, such as restoration of loss of bone from injury, disease, cancer, healing of broken bones which will not unite, cure of disease, correction of deformities, stabilization of joints, and so on.

The inlay graft in long bones is a perfect example of the ploughed-and-tongued joint, as well as of the application of like tissue to like. It is therefore a complete response both to the biological demands of comparative botany and physiology and to the principles of mechanics that guide the joiner.

The inlay graft (Figure 5) is applied principally to the broken long bones which fail to unite. In typical non-union, the ends of the fragments are avascular or anemic, circulation being deficient for a greater or lesser distance back from the region of the fracture. The bone is hardened and contains few, if any, active callus-forming cells. Its vitality, and hence its power of regeneration, is slight. A bone-graft inlaid into the fragment, reaching far enough back to tap the blood-supply and sources of nutrition and osteogenesis or bone formation in the healthy bone of the host, will bring to the zone of non-union forces which are of the same order as the reparative and osteogenetic power of recently fractured bone. The source of regeneration lies mostly in the soft-tissue structures that sheathe the bone and are enclosed in its medullary canal as well as upon the surface. Hence the graft and graft-bed are at best the full thickness of the bone cortex, so that like tissue may make contact with like, from marrow to periosteum. The vascular channels, especially the capillaries, in graft and host bone unite. Thus the graft obtains nourishment, not only for its own existence and subsequent growth and rearrangement, but for the nutrition of the avascular and impoverished ends of the fracture fragments.

ONE must not picture the graft as persisting in the form of a slender bridge between two fragments of sclerosed or hardened bone. The graft not only throws out callus and ossifies it, but responds to biological demands. It enlarges and thickens almost to any degree and takes on the structure of the host bone. More than that, the sclerosed fragments respond to the demands of restored function. Just as disuse brought about atrophy of the organic structures (vascular and cellular) in the useless fragments, so now restoration to usefulness and subjection to stress stimulate reconstruction of the fragments. Vessels grow in, the dense bone is absorbed and the original structure is eventually restored. It is again Wolff's law of stress, which is only one striking expression of the law governing the relation of structure and growth to function, whether it be in the animal or vegetable kingdom. This law of stress is omnipresent in all living supportive tissue. It determines that the diameter and strength of the trunk of a tree shall be larger than any other portion of that tree. By the same token, the contour, size and strength of the human skeleton are controlled by the stress demands incident to the part. This is also true of a bone-graft used to replace or repair a bone.

In the vegetable kingdom the conformation of the graft and its bed is always some modification of the inlay, whether it be the bud of the orange or the scion of the apple-tree, and so on. In the case of the bone-graft, besides a contact with host tissues that insure its living, there arises a multitude of mechanical demands which would tax

the ingenuity of the most versatile boss carpenter, joiner, cabinet-maker or machinist.

However difficult and exacting the piece of bone cabinet-maker work may be, it is necessary to add a still further fact that is true of all surgical problems —the all-important factor of time. The patient is under an anæsthetic, the tissues are open and exposed to the devitalizing influence of the air, instrumentation, and so on. Every instrument or tool must be made sterile by boiling. Bone, being always surrounded by muscles or other soft tissue, is never favored by circumstances comparable to those surrounding material being worked upon in the shop. Because of the hardness, brittleness, and knurly character of bone, and the inability of the surgeon to avail himself of the advantages of the anvil or vise to fix and hold the bone which he cuts, the chisel and mallet are at a disadvantage. Rotary, electrically-driven tools are thus a great advantage.

THE surgeon's difficulties, above indicated, have been largely overcome by making available to him the great advantages of the various automatic cutting tools, electrically-driven. In fact, the writer has designed a bone mill along these lines (Figures 2, 4), which enables the surgeon to shape the bone at the operating-table, under surgical sterile conditions, with the same variation and facility that are possible in shaping wood in the carpentry shop or metal in the machine shop. The various motor-driven male cutters (Figure 6, *B*, *F*) shape parts that fit accurately into other parts shaped with corresponding female cutters (Figure 6, *G* to *P*), however quickly the work is done. With this surgical mill, inlays of every variety are rapidly accomplished. These vary from straight inlays to crosses, double crosses, T's, irregular shapes, and so on, of a great variety. The cutting tool for this work is the twin saw, which is as adjustable as the calipers, and in fact is used as a cutting calipers. In this instance the twin saw serves as both the male and female cutter.

The graft may be shaped into any sized peg desired, by means of the lathe attachment. A close fit is assured by selecting the appropriate sized drill (Figure 6, *O*, *P*) when making the hole for such peg grafts. It is important that the fit should be that of the accuracy of a glass-stopper in a bottle, and not that of a cork stopper, or a square peg in a round hole. Compression may kill bone cells, either in graft or host tissues, or close blood-vessels that should otherwise bring nourishment to the living graft cells. If, by chance, a screw is needed for the human reconstruction, threads are cut upon the peg by pushing it through an electrical rotating die (Figure 6, *F*) which is incorporated in the mill. The drill hole which is to receive the screw is threaded by the corresponding sized tap.

The successful living bone-graft is based upon a tripod of exacting conditions and environment as to mechanics, physiology, and biology. The fit must be exact for a double purpose, to assure fixation and immobilization of the graft as well as the parts it is to repair. This makes for the early and profuse vascularizing of the graft by the penetration into it of blood-vessels from the host tissues.

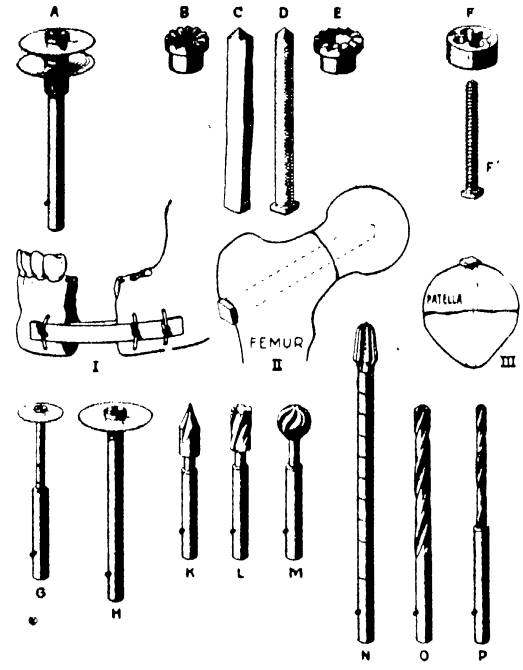


Figure 6: ***A*** **is the twin saw. Speed 3000 r.p.m.** ***B*** **is a miller for pointing the end of a bone dowel, as in** ***C.*** ***D*** **is a dowel after rounding in** ***E,*** **and** ***F*** **is a die for threading a bone screw like** ***F'.*** **Dowels and screws like these are made on the spot from bone removed from the patient's own body and inserted elsewhere in it—all in one minute by the clock.** ***I*** **is a jaw bone, with an inlay taken from the shin. Not only does the living bone unite with the jaw bone, but it grows, filling in the whole gap. Note ordinary machinist's twist drills** ***O, P,*** **for boring holes for dowels**

The query may arise, is this exactitude necessary? The answer is, the proof of the pudding is the eating. By using such methods, many successful results have been secured where operative failures up to 14 have preceded in a single case.

Reparative operations are often done long after the loss of bone, when the urge to repair has nearly or completely ceased. The surgeon must liken himself to a cabinet-maker who finds that he is running short of glue, and then must make his fits all the more exact, so that the glue will be sufficient. In the case of bone, callus is the glue.

The inherent biological urge to repair, which follows an injury to bone, diminishes to a varying degree as time elapses. The fresh cuts made in the bony elements at the operation tend to revivify this to a degree, but it always devolves upon the surgeon to select bone for reparative purposes, of the highest inherent callus-forming potentiality. It is well known that tibial bone has a higher degree of bone forming capability than bone from the spinal column, hence the use of the shin bone for graft material.

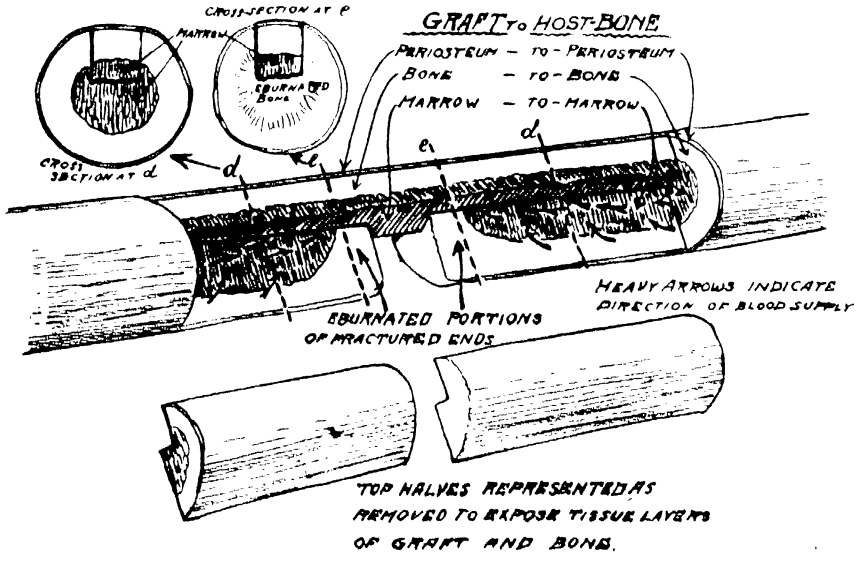
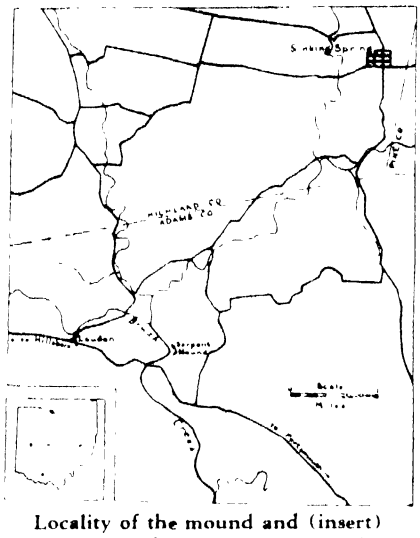


Figure 5: **Showing the principle of an inlay graft. First note old, stubborn, unclosed gap between ends of bones. Next, the long, slender, square piece of shin bone which has been set across it as an inlay. The two pieces in the foreground are not a part of the graft but are merely shown here** ***as if*** **removed, in order to permit showing the situation inside of a bone. "Eburnated"=hard**



Locality of the mound and (insert) a general finder map. Note dot

THE GREAT SERPENT

By CAPTAIN DACHE M. REEVES

LIKE a gigantic snake stretched out to sun itself, the Great Serpent Mound lies on the crest of a ridge overlooking Brush Creek in Adams County, Ohio. With the tail coiled at one extremity of the ridge, the body winds in sinuous loops to an imposing head. At the tip of the head the ridge terminates in a sheer cliff 100 feet above the creek bed, with a narrow rock point jutting out to form the tongue of the serpent.

The most striking view of the Great Serpent is obtained from the air. As one flies over the wooded ridge in summer, the folds of the serpent are disclosed beneath the trees, with the head prominently displayed on the brow of the cliff. In autumn, when the leaves are turning, the ridge lies beneath the airplane in a blaze of color; oranges, reds, browns, and yellows, with the green serpent conspicuous amid its surroundings. On a winter flight the whole ridge is visible through the bare limbs of the trees, with the serpent fully exposed.

The Great Serpent Mound is the largest prehistoric effigy known. Located in a region of natural beauty, it dominates the ridge on which it lies, and presents a most impressive appearance. It is unique among the monuments of ancient America. Two other serpent effigies are available for comparison: The Otonabe mound in Canada and the famous stone serpent of Loch Nell in Scotland, but these latter are smaller and lack the grandeur of the Ohio Great Serpent.

The length of the serpent, following its loops and coils, is 1330 feet, or just over a quarter mile. The width of the mound is 20 feet, with an average height of four feet. The head is highly conventionalized, as is customary in prehistoric art. In the center of the oval is a small mound of stones showing signs of fire. This may have been used as an altar. The fact that no human remains were found in the Great Serpent Mound shows that it was not a burial mound.

THE construction of the mound required an immense amount of labor. Its builders possessed only crude shell or stone digging tools, and their sole method of transporting earth was in basket-loads. Under these conditions it required a strong motive to undertake such a large task.

The questions naturally arise—why was the Great Serpent Mound built? Who were its builders? When was it raised?

None of these questions can be answered as yet. It is probable that the

The Great Serpent Mound clearly shows in this photograph, taken from the air near the head

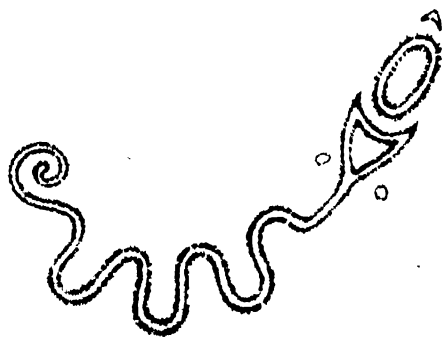
Mound in Ohio

The Great Serpent Mound. The cliff mentioned in the text lies behind the dense trees at the right

Great Serpent Mound had a religious significance to the prehistoric people who labored to erect it. The presumption of serpent-worship is strengthened by noting that representations of the serpent have been found in excavating other mounds in Ohio. A highly conventionalized serpent head executed in native copper was found in the Hopewell Mound. This same mound yielded a rattlesnake carved in stone.

Who built the Great Serpent? The answer is—the Mound Builders. But who were they? From excavations and study of the objects found in mounds, it is possible to learn a great deal about the life of these peoples. As Ohio contains over 4000 prehistoric mounds and other earthworks, a vast amount of material has been collected. This has enabled the identification of several distinct cultures among the Mound Builders.[1]

Even if we determine which of the cultures pertains to the builders of the Great Serpent Mound, the question of age still remains. That its builders were pre-Columbian is clear from the fact that its purpose and history were unknown to the natives living in this area in historic times. Hence its age must be reckoned in centuries. Its exact age is unknown, though there has been much study on this subject. Various estimates have been made, but so far these are nothing more than speculation. It is possible that future discoveries by archeologists will furnish answers to some of the unsolved problems. Yet scientific investigations may fail to determine when the Great Serpent Mound was built. Like the famous Stonehenge on Salisbury Plain in England, the great Ohio effigy may keep its secret inviolate.



Plan of the mound. The two "dots" may represent a horned serpent

Many of the prehistoric earthworks of America have totally disappeared beneath the plow, and the Great Serpent Mound narrowly missed a similar destruction. It had been cultivated for a number of years, and gradually was being worn away when, due to the efforts of Professor Frederick W. Putnam, it was purchased and restored by Peabody Museum of Harvard University. The funds for this were furnished by a few ladies in Boston. Later a deed to the site was transferred to the Ohio State Archeological and Historical Society, and the area containing the effigy is now a State Park. Thus the preservation of this magnificent monument of prehistoric America is assured for all time. On its lofty ridge it rests, a lasting memorial of the hopes and fears of an ancient people who have long since disappeared from the face of the earth.

[1]Authorities on American archeology know of no acceptable evidence that the Mound Builders were other than Indians.—*Ed.*

MINOR PLANETS—II

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society

LAST month's account of the minor planets told far less than half of the story, whose details, even under drastic condensation, fill the portly volume [mentioned last month.—*Ed.*] from the University of California. When an asteroid has been discovered, accurately observed, followed till its orbit can be calculated, and duly listed and named, the specialist's work is not over: In fact, the heavier part of it is just beginning.

Even if a planet pursued exactly the same course about the sun in every revolution—as it would if there were no other planets to attract it—there would be a good deal to do before the demands of accuracy were satisfied. Theoretically, if we had three absolutely precise observations of the position of a planet in the sky—that is, of the direction in which it lay from the earth on three different dates—we could then calculate its orbit exactly, and predict where it would be, any number of years in advance (so long as no outside forces modified its motion).

THE mathematical processes involved, though fairly complicated, are definite, and a day or two of work by a practiced computer should give him the solution—though the novice would probably require a fortnight.

But no human observations are perfectly accurate and, by the very nature of the problem, small errors in the data usually produce very much larger ones in the calculated results. As a simple illustration of such a situation, suppose that we have to determine the circle passing through three points, *ABC*, Figure 1. Our school geometries give the answer: Draw lines through the middle points *D* and *E*, of *AB* and *BC*, at right angles to these lines. These new lines intersect at the center *O* of the desired circle. The school-book diagram looks like child's play.

But now suppose that *B* is very nearly in line between *A* and *C* (Figure 2). We draw our lines through *D* and *E*, as before: They are not quite parallel, and must intersect at some point far beyond the bottom of the page. If we could draw our lines with the absolute perfection assumed by Euclid, all would be well. But it is evident that the slightest error in drawing these lines may seriously alter the positions of intersection, since they cut at what a surveyor would call a very unfavorable angle.

The calculated size of our circle, and hence the length of time which it would take for a point moving at uniform speed to complete a circuit, may be greatly altered by these small errors. Yet it is clear from a glance at the figure that the erroneous circle will lie very close to the correct one between the points *A*

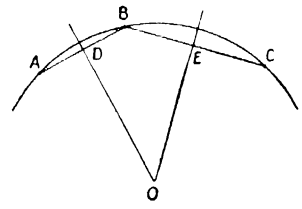


Figure 1

and *C*, and diverge but a little from it for some distance further to the right or left.

In the planetary problem, when our original few weeks' observations cover but a very small portion of the whole orbit, we have the same situation, aggravated by the fact that we have six numerical "elements" to find from our observations, instead of the three which suffice for a circle. If we start with slightly erroneous data, our calculated orbit will predict the motion pretty well for the first few weeks—which will make it much easier to get additional observations of the body. But when we seek to carry our prediction ahead for a year and more to the next opposition, the cumulative effect of the errors may be considerable, and we may have to search some distance from the predicted position to find the planet. If it is not picked up, the accumulated error will be much greater at the next opposition, and so on from bad to worse.

The condensed narrative of the "Research Surveys" are full of such instances: "At the next opposition, the planet was faint, far south, and in the Milky Way"—conditions which practically precluded its finding, before the days of photographic observation. Great labor was often spent in calculating the best available orbit from the existing observations—often not one orbit, but several, assuming various values for the most uncertain of the elements (usually the period). Search along the line marked by these possible positions sometimes picked up the planet: "Palisa rediscovered it after charting 2800 stars." Despite such care, a good many planets were lost—most of them to be found long afterward when wholesale photographic searches became customary.

When a planet is observed at the second opposition our knowledge of the orbit is better, but still imperfect. Only when observations had been made at four oppositions, with the planet in four different parts of its orbit, could the computer rest from his labors, confident that, under the vastly simplified assumptions which we are still making, his predictions could point our telescopes to the planet for a century to come.

BUT, unfortunately for the lover of simplicity, our simplified assumptions are very far from true. The planets are continually pulling and hauling upon the asteroids by their attraction, altering their motions, and causing them to diverge from the predictions of the too-simple theory. During the few months, at most, for which a planet may be observed after its discovery, before conjunction with the sun, the perturbations thus produced are usually small; but, for the reasons already explained, an orbit calculated from the disturbed positions, on the hypothesis that the sun's attraction alone is acting, may be considerably wrong. Here is a new problem to solve: Suppose there was another sun, just like ours, but with only one small planet circling around it: Suppose that at some given instant (during the time covered by the observations) the imaginary planet was at exactly the same distance and direction from the imaginary sun and moving in exactly the same direction and rate as the real asteroid. The only difference between their past and future motions will be that the real planet is subject to the attractions of other planets, and the fictitious one is not. It is then a perfectly definite and straightforward problem (though not an elementary one) to calculate just how much the positions of the two planets, each referred to its own primary, will differ at any other time. When this is known, the computer can make the corresponding changes in the observed positions of the planet, and so, for the purposes of his calculation, abolish the planets, or at least their attraction on the one he is studying. He may then apply the simple theory to the corrected observations, and so get an accurate calculation of the orbit of the imaginary asteroid about the imaginary sun. Applying the differences already computed,

he then finds at last where the real asteroid was, relative to the real sun and its planets. Going on in this way, every new year's observations of the planet enables him to get more accurate values of its period, mean distance from the sun, orbital eccentricity, and so on. Some of the older calculations may have to be revised with the new figures, but finally a really reliable determination of the orbit will repay him for his work.

Here, at last, one might suppose that it would be time for the weary to rest. But, alas, this method of calculation of the effects of planetary attractions—which is known as the method of special perturbations—can be made only step by step, for successive intervals of perhaps 40 days (each step must occupy only a small fraction of the planet's period). The computer may go on as long as he likes; but there are two troubles which beset him. First, even a very small error in the earlier steps (such as arises from working only to six decimal places) will gradually be magnified as the calculations proceed. By keeping continually in touch with new observations as they are made, such errors can be detected and corrected. Second, the step-by-step calculation is costly of time—which is money. This is particularly annoying if a planet is rediscovered after 30 or 40 years. It is a relatively simple matter to calculate an orbit from the earlier, or from the later, observations; but to determine what part of the differences between the two arises from the action of the planets, and whether the rest is interpretable as the result of errors in the observations, demands a plodding calculation for every few weeks throughout the long interval.

WORSE still, the carefully acquired knowledge of the present can be made available for the future only by similar laborious calculations. To stop computing the perturbations is the same as assuming that, after the time when we grew tired, the planets stopped attracting the asteroid, and the positions so calculated may run away so far from the true ones that, after a decade or so, the planet is practically lost. When only a few dozen minor planets were known, it was fairly possible to keep track of them all. Now that the number is far above a thousand, only objects of special interest—such as Eros—can be followed up in this expensive manner. Hence, time and again, in the "Research Surveys," one may read such history as "Accurate ephemerides were discontinued in 1886. The planet was rediscovered" (photographically) "in 1906, 1907, and 1910. The only accurate positions since 1886 seem to be in 1907, '10, '14, '18."

The predicted positions of the principal planets and of the moon, given in the Nautical Almanac, were not derived by step-by-step integration. By very extensive analytical developments of theory, it is possible in these cases to derive "general perturbations"—formulas which express the whole motion, under the combined attractions of the sun and the planets, in such a way that the longitude and latitude in the orbit, and the distance from the sun (or from the Earth, in the moon's case) may be calculated for any given instant—a century hence or two thousand years ago without figuring out all the intermediate motion.

In principle, the same methods are

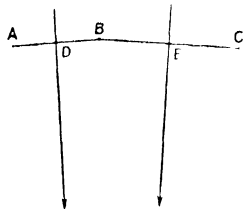


Figure 2

applicable to the asteroids—except perhaps for a few unusually difficult cases. There exists a "mean orbit" varying steadily, and very slowly, with the time, such that a planet moving around the sun in this orbit will never be very far from the actual one. The difference may be represented as the sum of a great number of periodic terms—each one a perfectly regular oscillation of fixed period and range. Theoretically, the series is infinite. In practice, several hundred terms are required to permit the calculation of the moon's longitude as accurately as it can be observed. For Jupiter and Saturn, the number of terms required is large, for the inner and smaller planets, somewhat smaller.

Many asteroids come so near to the massive Jupiter that an enormous number of terms would be required to represent their motion to the highest observable accuracy; that is, to 0.″1 or better. This has been attempted, with considerable success, for one or two minor planets, notably for Vesta, the brightest of them all, but the enthusiastic analysts who have done so well were wise enough to pick out simpler cases, in which the algebraic work would not take more than a few years!

For the great bulk of these bodies it would be chimerical to attempt anything like this accuracy. But it is a wholly reasonable scheme to compute the mean orbit and the largest of the periodic terms—which are not very numerous. By taking these into account, predictions should be feasible, even after many years, with an error of but a few minutes of arc, even in rather unfavorable cases. What is more important, these individual errors due to the incompleteness of the tables will oscillate back and forth as time goes on, but not increase steadily, so long as the job of finding a mean orbit has been well done.

The present hope of workers in this field is to get such mean elements and principal perturbations for as many planets as possible. A surprisingly large quantity of such work, including, with more or less accuracy, about 400 planets, is summarized in the "Research Surveys," and it is stated that at least 75 percent of the 1300 planets which had been numbered when the census was closed could be handled in the same manner.

The work of calculating the perturbations, comparing with the observations to find a mean orbit, and from this deriving the final results, is a very considerable task for a single planet. To do so for a thousand planets is an enormous job, which is likely to remain long incompleted despite the fact that tables have been prepared which shorten the labor.

THE two hundred or three hundred harder cases are of various types. One example is (499) Venusia. This planet has a period of 7.83 years, a high eccentricity (0.22) and a small inclination (2 degrees). At aphelion it is 450 million miles from the sun, and less than 40 million from Jupiter's orbit. Should the planet come to this point while Jupiter was at its nearest, Jupiter would appear, to an observer on its surface, as a disk 480″ in diameter (one quarter of the size which the sun looks to us), and the sun itself only $\frac{5}{6}$ as big! At this time, Jupiter's attraction on the planet would be almost $\frac{1}{7}$ as great as the sun's. The asteroid would move at 12 km/sec, a little slower than Jupiter (13.1), so that the two bodies would remain near one another for a long time—about two years. Such an encounter would produce very extensive changes in the planet's orbit. It would be some time, however, before they happen, for at the last conjunction of the two (in 1918) Venusia was at perihelion, 3.1 astronomical units from the sun, and more than 2 units from Jupiter. The planet catches up with Jupiter once in 23 years, but it will be more than two centuries before a really close approach takes place. It is doubtful whether the general infinite series, which give an adequate expression for the perturbations in ordinary cases, would remain convergent in such extreme circumstances. The step-by-step method, however, will handle any motion—short of a case in which the planet actually collided with Jupiter—and, even then, would enable us to calculate the exact circumstances of the collision—so that there is no fear that the problem may get beyond the power of an analysis, provided, of course, that people with good telescopes are interested enough to keep on observing the planet, and others with good heads for figures care to keep up with the calculations.—*Princeton University Observatory, February 4, 1936.*

Just a pile of scrap metal—but destined to become an important factor in the production of steel

JUNK TO YOU

A Billion-Dollar Industry in Scrap Metals . . . Revolving Resources Save Ore and Coal . . . The "Alloy Age" Has Introduced New Problems

By PHILIP H. SMITH

SCRAP metal may be simply junk to you, but it is fast becoming our primary source of many metals and is already our one great revolving industrial resource.

Scrap is the biggest thing in steel. Certain mills now produce steel the year around without using a single ton of iron ore. And that saves both ore and coal. Scrap goes into the manufacture of non-ferrous products, too, and so is postponing the day when high-grade deposits of copper, lead, and zinc will be exhausted.

"Simply junk" is an important factor in controlling the rate at which obsolete industrial equipment is replaced. When scrap prices rise so does the value of old machinery and then replacements are stimulated.

Behind scrap is a billion-dollar industry, composed of thousands of small dealers and hundreds of big ones who operate independently, but who in the aggregate form a closely knit organization. Its sole function is to keep the metals in circulation. It collects a vast array of worn-out products, sorts them, grades them, sluices them into great "surface mines," ready for use again in the manufacture of new products.

Until quite recently, making metals go 'round and 'round was relatively simple. The scrap dealer merely sorted the ferrous and non-ferrous types and sold them for what they were. But the metallurgy of alloys is changing all that and making complex operations of both the handling and the use of scrap. What does the scrap dealer or the mill user do with alloys?

Before we can answer this question, which has so great a bearing upon the scrap industry and the entire metal-using world, a few definitions are necessary as well as a brief glance at existing practices. It is what is being done in the laboratory and the mill today that tells what lies in store for scrap.

BREAKING scrap down into classifications provides two basic types "home" and "open market" scrap. The former, representing normal wastes in production—such as cut-off ends of ingots, residues of fabrication, and the like goes right back into production. The latter comes closer to being junk as we know it because it includes all reclaimed metal. This type is further classified into non-ferrous material, which is routed to refiners, and into ferrous scrap which finds its way ultimately to steel and wire mills and foundries. Of the ferrous type there are 75 grades, but less than a dozen are universally recognized.

The recovery of non-ferrous metals from scrap is a highly organized, efficient business. Mining companies as well as independent refiners are engaged in it and their output is substantial. Old copper, for example, represents about one third of the total annual copper production. Lead ranks next to copper as a refluxing or circulating metal, and then follow aluminum, zinc, and tin.

Copper comes from a thousand sources and goes back into use in as many and as varied ways. Though copper is virtually indestructible and seemingly could reflux to balance with consumption, this is not the case. Home scrap eventually equals all consumption because it goes back into use, but there are losses from wear and through the dissipation of small objects. Supply is, of course, controlled by the obsolescence rate of copper products and this may or may not balance with consumption at any given moment. When trolley lines are abandoned, their lines are salvaged to augment scrap piles, but there are also busses taking their place and the busses have copper radiators. The balance may thus be restored very quickly.

Copper use today is significant because of the way in which it will affect the scrap market years hence. The growing practice of alloying with copper will bring no greater amounts of copper to the refiner but it will bring more alloy scrap to the steel mill and create a problem in steel production.

Lead does not return to scrap in proportionately as great amounts as copper due to its many dispersing uses. It goes into paint pigments, foils, bullets, and gasoline anti-knock compounds and never comes back. About 75 percent of all the lead in storage batteries refluxes with periodic regularity and can be counted upon for more than 100,000 tons annually.

Aluminum is still too young a metal to give much account of itself in scrap markets. But it is indestructible and presumably will reflux much as copper does.

Both zinc and tin scrap are mostly of the "home" type and little reaches the open market for reclamation. However, the phenomenal development of zinc die castings[1] presages recoverable metal in the near future; castings are already finding their way back to smelters for manufacture into zinc oxide.

The ferrous group, iron and steel, reflux to a high degree and scrap now constitutes about 50 percent of new steel content, though the percentage has been known to run as high as 64. All manner of scrap is used, but big units are preferred, both by the collector and the mill. A battleship, for example, being in itself a mine of various metals in easily handled form, is considered desirable scrap. Henry Ford thought a fleet of 199 war transports worth 1,600,000 dollars as material for "flivvers," and the British went to a great deal of trouble to raise the German fleet sunk at Scapa Flow to get metal which was valued at 13,000,000 dollars.

WHAT the big users want and regard as choice scrap are solid chunks of alloy-free metal and that, more than anything else, means, to the steel industry, railroad scrap—rails, old freight cars, and locomotives. But here is where a great change is coming over the scrap situation.

In 1924, the railroads of this country consumed 28 percent of the total steel output. Ten years later they took only 10.5 percent, and last year a mere 7 percent.

In 1924, the automobile industry accounted for 10 percent of the total steel consumed. Ten years later the figure had risen to 21 percent and last year to 25 percent.

Supplies of choice railroad scrap are definitely shrinking while automobile scrap, regarded as "poison" by the majority of steel producers, is mounting. Automobile scrap is unpredictable. A vehicle stripped of its radiator, lamps, battery and small fittings from which are recovered copper, lead, and zinc, leaves an engine block for the foundry, sheets coated with paint, and steel alloyed with a large number of metals such as chromium, nickel, vanadium, and molybdenum. The sheets can be used in small doses, but the alloys will upset the control of a melt unless their presence is definitely known and taken into consideration.

Here is a dilemma from which several possible escapes come to mind quickly. The first is for the steel mills to revert to ore for their raw material. Unfortunately this won't do because the economic reasons for using scrap remain operative. Scrap is virtually a surface mine, located nearest to the points of consumption, and freight differentials cannot be ignored. Nor can the mills overlook the two tons of coal and ton of limestone required to make one ton of steel from two tons of ore, with all that the process involves in material and handling costs.

A second solution would be to draw more heavily upon other types of scrap—bridges, old machinery, and the steel frames of buildings. These are already being used and while they would provide a solution, it would be temporary as will be shown later.

A final suggestion would be to ignore the implication of statistics and point out that the present situation can not last; there will be, as railroad finances improve, a revival of replacement which will throw upon the market adequate amounts of choice scrap.

One does not have to be an automotive visionary, however, to realize the ineffectualness of this solution. A revival of railroading would not necessarily restore the former equilibrium. There would be a substantial reflux of railroad scrap for many years, but a thoroughly modernized road will not re-equip with identical materials. It, too, will utilize metallurgical knowledge to create a future scrap problem; witness the new light-weight trains.

THE steel producer who succeeds in dodging the automobile only postpones the day of getting run over because, important as is the isolated scrap problem raised by the automobile, its real significance is in calling the change on the entire steel and scrap industries. We are entering an Alloy Age and in another 10 years we may see alloy steels accounting for one third of all the steel produced. The problem is greater than one of melting up old motor cars; it is one of using alloy scrap no matter what its source.

Though the steel industry may be charged with being backward about the use of alloy scrap, it has been forward in recognizing the onrush of the problem. For several years joint studies have been carried on to determine what residual metals were appearing in scrap and how rapidly the content is increasing, as a preliminary to meeting the problem in production. It has been proved that residual metals are increasing slowly, copper more rapidly than any other metal, and the opinion can be expressed that the increase will accelerate as alloy steels penetrate new fields.

Just take machine tools, for example. When cemented carbides began to demonstrate their essentialness to high-speed production, they also showed that existing machine tool equipment couldn't stand the gaff. So today we have a new crop of machine tools employing alloy steels to give added strength and rigidity without undue increase in weight. Now if machine tools maintain their rate of improvement, obsolescence will convert them into open market scrap within a very few years. And so it goes: agricultural implements, building construction, and almost every known industry is taking to alloy steels. The automobile industry is only the trumpeter in the march of metallurgical progress.

Alloying aims to increase strength without increasing the weight of a product, but it does not stop there. Corrosion resistance and strength with

Powerful shears for cutting up metal scrap

Scrap metal pressed into a solid chunk

[1] Scientific American, May 1935, page 254.

Pouring a melt of scrap from a modern electric furnace

greatly reduced weight are the real aims of the Alloy Age, and this development implies wider use of alloys and some substitution with such light weight, nonferrous metals as aluminum and magnesium.

FACED with the Alloy Age, what are the scrap and steel industries going to do about scrap? About the only contribution the scrap industry can make is to do a better job of sorting and grading in order to be able to offer the steel scrap buyer more uniform grades. It has even been suggested that scrap dealers melt down their material into pigs to be sold with known specifications, but this is an elementary, though important, step. After proper classification and grading has been done, there still remains the problem of use in the mills. Metallurgy will have to take over the matter at this point and the accomplishment which research has made to date is being reflected in work with the electric furnace.

All-scrap charges, high in alloy content, have been used in the open hearth type of furnace, but only when making such common products as nails, barbed wire, and woven wire field fence, where a wide latitude is not detrimental to the product. When better grades of steel were sought, practice has been to use quite a large percentage of pig iron or hot blast-furnace iron in the charge. Now comes the electric furnace which uses all-scrap charges for some of the better grades of steel, though by no means all of them, and there are certain mills which are operating without the use of a single ton of iron ore or pig iron. Records of mill operations show that such miscellaneous scrap as turnings, borings, flashings, clippings, punchings, foundry returns, and light scrap, is being used in the production of steel, the electric furnace permitting control of the reducing or non-oxidizing atmosphere and slags to produce a well degasified product and one more resistant to atmospheric corrosion by virtue of greater solidity.

In the manufacture of cast irons, the electric furnace can be operated with all-steel or all-iron scrap charges, whichever is available and cheapest. Oxidizing and reducing conditions are under control and an analysis of the charge can be made during the heat. Should adjustments be needed they can be made while the charge is still in the furnace. Largely because of the electric furnace, cast irons are now being produced with a tensile strength of 40,000 pounds per square inch, whereas a strength of 25,000 pounds was thought excellent a very few years ago.

For the scrap industry to put up with alloys leaves them in the class of liabilities and, of course, the grade of steels produced is definitely limited. An advance, therefore, is to utilize the alloys so that they become an asset, and this, too, is being done. When the alloy content is known and the use is predictable, certain alloyed steels can be produced. Both nickel and molybdenum alloy scrap can be remelted in an electric furnace without loss of the alloy and this explains why a few steel producers regard some alloy scrap as premium material.

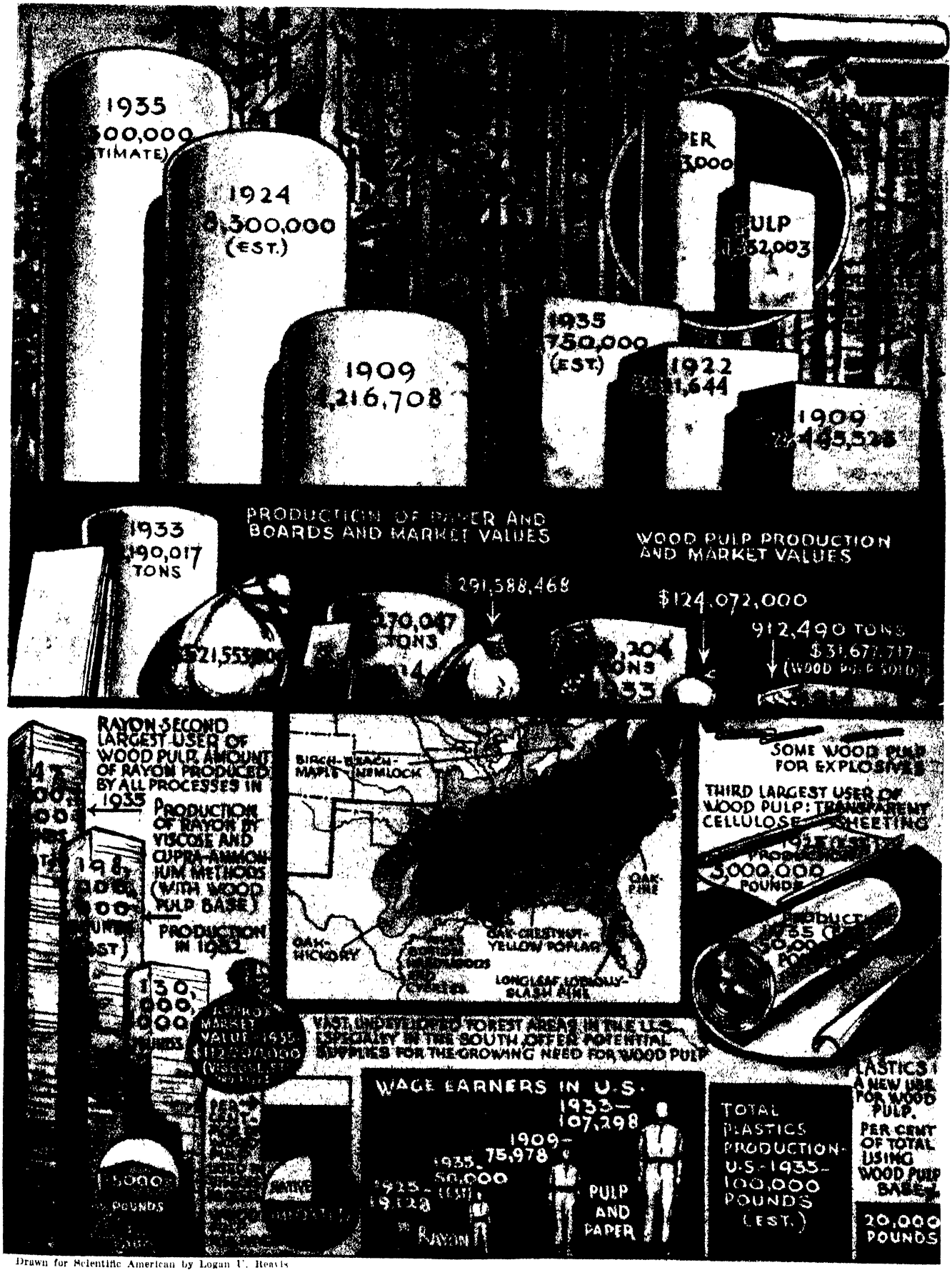
CRITICS may raise the cry that the electric furnace is a very insignificant factor because the furnace unit is small and accounts for a proportionately small tonnage. This is a half truth. The whole truth is that these furnaces are increasing in number and their rapid operation gives a large output in the aggregate. If electric power costs go lower, they will become even more dominant and they can be counted upon to provide an outlet for a large scrap tonnage.

The Alloy Age is also becoming a "Tailor Made" steel age, with special products made for special uses and each and every use dictating its own product specifications. This implies that there will be more pressure than ever to control processes and to know within very close limits just what goes into the melt. It is a demand that works counter to the use of scrap and particularly to the scrap of the future.

Knowing what is going on in laboratories, we might hazard the opinion that a means will be found for drawing off the unwanted alloys from the furnace while in the molten state. This is a dream of metallurgists and there are many working to translate it into reality; but the whole scheme is still too nebulous to warrant placing any dependence upon it. It is much more likely that the solution will be approached through an improvement of present technique—through finding more and more ways of making alloy scrap predictable through an accumulation of mill experience.

Here, in the scrap situation, is a splendid example of industry faced with a problem which it cannot dodge. Here is a challenge worthy of full and prompt acceptance; and just because the demand to meet it is so imperative, there will be a satisfactory solution. When that time comes, scrap metal will be everywhere accepted as our national resource Number One.

Photographs courtesy Institute of Scrap Iron and Steel, Inc.; Northwestern Barb Wire Co.; and Pittsburgh Lectromelt Furnace Corp.



Drawn for Scientific American by Logan U. Reavis

THE AMAZING GROWTH IN THE USE OF WOOD PULP

THROUGH the efforts of chemical and mechanical engineers, there has been a steady increase in the use of wood pulp in many fields other than the production of paper. The drawing shows the important phases and figures. It is readily apparent that the future uses of wood pulp will depend largely on intelligent re-forestation and intensive chemical research directed toward the utilization of less favorable types of trees such as abound in the East and South.

TRISECTING THE IMPOSSIBLE[1]

Why the Angle Trisector is Wasting His Time . . . the Problem is Insoluble—Demonstrably So . . . But the Perennial Aspirant Works On and On

By A CONTRIBUTING EDITOR

THE ancient angle trisection problem, provably insoluble, is regarded as a "chestnut," both by mathematicians and the editors of scientific journals; why, then, is a discussion of it dignified by insertion here? Because, properly or improperly, this age-old problem periodically becomes news every time an aspirant to its solution manages to convince a local reporter that he has solved it, and thus gets the "news" put on the wires all over the nation—which happens about once a year; because millions of wondering newspaper readers are thereby genuinely puzzled; because many of our readers, willing enough to believe the mathematicians who say the problem cannot be solved, would nevertheless like to know why; and finally because the demonstration will be an answer to all those who, challenged by assertions as to the futility of the attempt to trisect an angle, have continually sent this journal their solutions throughout the past several years. Unfortunately, as is the case with the Einstein theory, the demonstration cannot be explained entirely unmathematically.

There are at least three kinds of angle trisectors: first, those who sincerely hope they can solve this problem; secondly, those who misunderstand the terms on which it is based (compass and straightedge but *no measuring*); third, some who believe they can do what others cannot do, to put it as charitably as possible.

The accompanying article is definitely not a bid for solutions; just as in the past, we still cannot undertake to examine them. This is not merely a problem whose solution has not yet been found; it is one which is *provably* insoluble. No doubt the energy which has been devoted to the many attempts at solution which have been sent us would have dug the Panama Canal or moved the Pyramids of Egypt to Antarctica.—*The Editor.*

ALL of the stir which invariably occurs whenever the newspapers report that John Doe, "a humble man with none of the advantages of an advanced education, has succeeded in trisecting any angle, a problem which has baffled the greatest of mathematicians to date"; or more recently, that the eminent Blankety Blank has succeeded "where generations of mathematicians have failed"—finds its ultimate origin in the aversion of Plato (429-348 B.C.) for all geometrical constructions involving the use of instruments other than a ruler and compasses. By a "ruler" we mean here a straight-edge *without graduations.*

Hippias (about 420 B.C.) devised an instrument which would construct a curve, called the quadratrix, by means of which he could trisect an angle, or indeed divide it in any given ratio. However, Plato's influence over his contemporaries was so great that the restriction to straight lines and circles not only became the rule of the day, but was observed by his successors, including Euclid (330-275 B.C.), and the search for a method of trisecting an angle under this restriction was begun. The search has continued, in spite of the fact that it was shown by various writers during the past century that such a construction is impossible when one is restricted to a ruler and compasses.

It is the purpose of this article to outline the argument by means of which the impossibility of this construction is demonstrated. On account of its complexity the argument will not be given in detail, but frequent references will be cited, in order to enable the advanced reader to obtain proofs of assertions not completely proved here. Notable efforts have been made by Felix Klein, Leonard E. Dickson, and others to bring this matter to the public eye, in the hope of reducing the number of individuals who waste their time trying to discover this impossible construction.

Special attention should be drawn to Professor Dickson's proofs (see the bibliography at the end), not only for their frequent occurrence in mathematical literature, but also for the variety of methods he has employed; it is his thesis that such an important question should be dealt with in more than one way. The present writer wishes to acknowledge his great indebtedness to the previous work of Professor L. E. Dickson.

No doubt the reader wonders why, if proofs are available, books on elementary plane geometry do not devote a section to demonstrating that angles cannot be trisected, polygons of seven and nine sides cannot be constructed, and so on. The reason is that elementary plane geometry is not powerful enough to answer this question; in order to prove that a given problem for construction was insoluble it would be necessary to examine every last one of the infinite number of imaginable constructions, one of which might be successful. This is especially unfortunate because many people who dislike other forms of mathematics are fond of plane geometry; it affords excellent mental discipline and is excellent training in clear thinking, since it requires a special procedure for each and every problem attacked.

Descartes realized that a method, such as the one just mentioned, which required a special procedure in each case, possessed a great weakness as far as research was concerned, and pointed out that by analytical geometry it was possible to lay down a few simple rules by means of which a given proposition could be proved or disproved immediately. Plane geometry has its merits, and ought not be discarded; it will often yield an elegant proof of some proposition that has been found to be true by other methods, but it is weak in connection with propositions not known to be valid beforehand. Consequently, before turning to the special problem at hand, it is necessary to formulate some of the usual geometric ideas in terms of analytical geometry.

"Analytical geometry," according to W. W. Rouse Ball in "A Short Account of the History of Mathematics," "does not consist merely, as is sometimes loosely said, in the application of algebra to geometry: that had been done by Archimedes and many others, and had become the usual method of procedure in the works of the mathematicians of the 16th Century. The great advance made by Descartes was that he saw that a point in a plane could be completely determined if its distances, say x and y, from two fixed lines drawn at right angles in the plane were

[1]An abstract of a paper presented before the Lawrenceville Science Club.

given, with the convention familiar to us as to the interpretation of positive and negative values; and that though an equation $f(x,y)=0$ [for example, $7x+2y+6=0$] was indeterminate and could be satisfied by an infinite number of values of x and y, yet these values of x and y determined the co-ordinates of a number of points which form a curve of which the equation $f(x,y)=0$, expresses some geometrical property; that is, a property true of the curve at every point on it.

"It was at once seen by Descartes and his successors," Ball continues, "that in order to investigate the properties of a curve it was sufficient to select any characteristic geometrical property as a definition, and to express it by means of an equation between the (current) coordinates of any point on the curve, that is, to translate the definition into the language of analytical geometry. The equation so obtained contains implicitly every property of the curve, and any particular property can be deduced from it by ordinary algebra without troubling about the geometry of the figure. The points in which two curves intersect can be determined by finding roots common to their two equations. . . ."

In this day and age, when the subject of graphical representation is being taught in high schools, and graphs are being used to portray business fluctuations, the above quotation will very likely recall to mind a subject studied somewhere or other once upon a time.

THE Straight Line and the Circle: Since we are interested in dealing with our problem in terms of Euclidean geometry, it is necessary for us to make certain assumptions, with Euclid, upon which to build our analysis. Therefore we say: Let it be granted that

1) A straight line may be drawn from any one point to any other point.

2) A terminated straight line may be produced to any length in a straight line.

3) A circle may be described from any center at any distance from that center.

4) All right angles are equal.

5) If two straight lines in a plane meet another straight line in the same plane, so that the sum of the interior angles on the same side of the latter straight line is less than two right angles, then the two straight lines will meet on that side of the latter straight line.

From these postulates, together with some axioms and definitions, Euclid builds his entire structure of plane geometry. If we are to examine the problem of the trisection of an angle in terms of analytical geometry, it is evident that first we must obtain the analytical equivalents of Euclid's straight lines and circles.

It is shown in books on analytical geometry that any straight line whatsoever in a plane can be described with reference to a fixed pair of rectangular axes in the same plane by the equation

(1) $Ax+By+C=0$

in which both A and B cannot be zero simultaneously. If one of these is zero, say A, then the line is parallel to one of the axes, in this case parallel to the X-axis. If C is zero, this means that the

line passes through the point of intersection of the axes, called the origin. Since both A and B are not zero in any given case, by dividing through by the one different from zero, say A, one obtains two ratios, in this case B/A and C/A, and both of these ratios must be known in order to determine the line uniquely. This is the analytical analog to the well known geometrical fact that it takes two points to determine a straight line uniquely.

Similarly, in analytic geometry it is found that any circle can be described by appropriately choosing the values of D, E, and F, in the equation

(2) $x^2+y^2+Dx+Ey+F=0$

Here it is necessary to know the exact values of *three* constants in order to determine the circle uniquely. This is in accord with the geometrical fact that if three points on a circle are known, then it is completely determined (that is, one circle and only one circle can be constructed so as to pass through three points not on a straight line).

The Nature of a Construction: In order to investigate the exact nature of a geometrical construction it will be helpful to consider a specific problem. Therefore, let us suppose that we have been asked to construct a straight line parallel to a given straight line and passing through a given point not on the given line. The complete solution of this problem may be divided into distinct steps:

a) What data do we possess? We are given a definite straight line, and a definite point not on this line. Since two points are required to determine the straight line, our data consists of *three points* (say A, A', and P) whose locations we know exactly.

b) What tools have we at our disposal? In the assumptions we have made we grant that it is possible to draw a straight line through any two known points, and that it is possible to construct a circle of given radius about a given point as center. Therefore, since we do not wish to increase the number of our assumptions, we must limit ourselves to *straight lines* and *circles*—these are our tools.

c) What do we wish to do? Since two points completely determine a straight line, we see that our construction requires the location of a *new point*, say P', such that the straight line PP' will be parallel to the given line AA'. How to locate not just any point, but some particular point which will determine (in conjunction with P) the desired line, is our problem.

d) A construction having been effected, we must prove that it solves the problem exactly.

The features of the above analysis that should be noted carefully are: 1) the exact knowledge of *certain points* contains all of the given information, and 2) the solution of the problem reduces to locating a *special new point*. This type of analysis carries over to any construction whatever, so that any construction which is sought depends for its solution on the location of an appropriate new point (points) which is to be located as the intersection of two straight lines, one of the intersections of a circle with a straight line, or as one of the intersections of two circles with each other, all the circles and straight lines used in the construction being determined by given points and new points constructed directly from given points.

THEREFORE, the possibility or impossibility of a desired construction depends upon whether or not the essential new points involved can be constructed from the given points as intersections of straight lines and circles. This leads to the subject of constructable points.

Before proceeding to an important theorem, let us recall to mind the implications of the word "rational," as used in mathematics. First, we remember that the arithmetical processes of addition, subtraction, multiplication, and division are called the rational operations, whereas the operations requiring the use of the radical sign ($\sqrt{\ }$) are termed irrational operations. Consequently a quantity is said to be a rational function of some other quantities if it can be expressed in terms of these latter by means of the rational operations alone, that is, without radical signs. Likewise, the roots of an

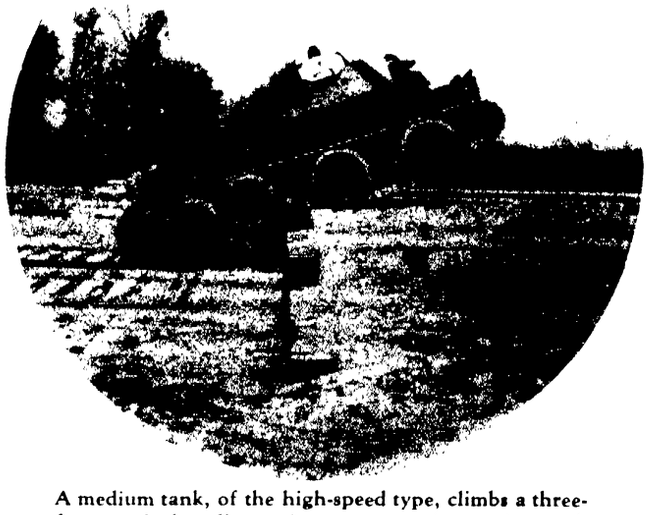
(*Please turn to page* 228)

see a 75-mm gun carriage go bouncing down the cross-country course, towed a prime mover at high speed, is to marvel at the strength built into it

CAN THEY

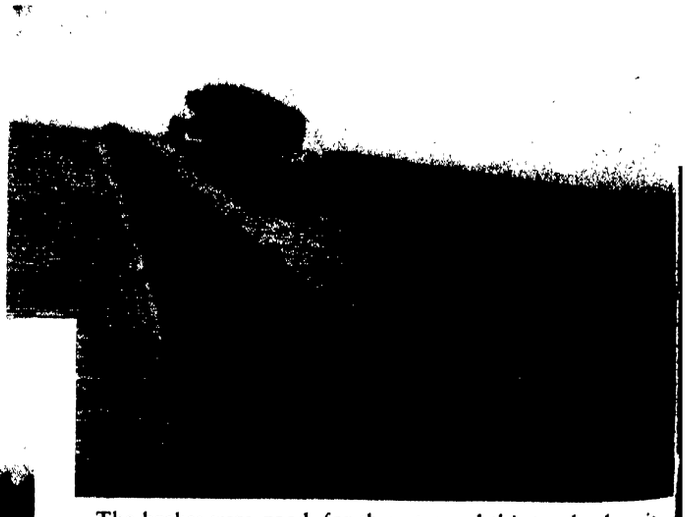
MANUFACTURERS of motor vehicles maintain such elaborate proving grounds that the layman is likely to think that the tests conducted thereon are sufficient to indicate a vehicle's ability to perform satisfactorily under most known conditions. This is fallacious reasoning. The ability to negotiate hills, curves, and mud, sand, and water holes on a commercial proving ground do not mean that a vehicle will stand gruelling military service. The military engineer, moreover, is interested not alone in the ability of any mechanism but also in its capability.

At the Aberdeen Proving Ground, Maryland, the Ordnance Department of the United States Army tests all types of ordnance equipment, tries out new weapons to overcome defects, tests and retests in order that only equipment which is as perfect as man can make it will be adopted for service. Their duty, in these days of rapidly increasing mechanization and motorization of the Army, includes thorough investigation of all Army vehicles. "It is the aim of the Proving Ground," says Lieutenant-Colonel G. M. Barnes, writing in *Army Ordnance*, to whom we are indebted for these illustrations, "so thoroughly to conduct automotive tests that any vehicle, whether of Ordnance Department or commercial design, receiving the approval of the Proving Ground may be



A medium tank, of the high-speed type, climbs a three-foot vertical wall, putting great strain on its track

his light truck is not an amphibian, yet it carries "a bone in its teeth" as tows a gun-carriage through the concrete water course—an extreme hazard



The brakes were good, for they stopped this truck when it was towing a three-inch-gun mount down the slope course

The resistance to traction, of a vehicle, is found by mometer. The pull of the vehicle being towed is recorded

TAKE IT?

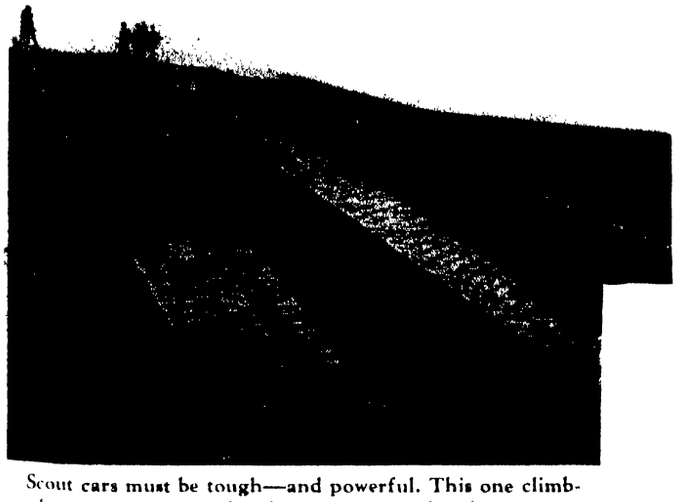
expected to give reliable service when issued to the combat arms of the Army."

As most cross-country fighting vehicles are of the track-laying type, the Ordnance Department is primarily concerned with this general class. Wheeled vehicles, however, are also important, as this type is used in scouting, reconnaissance, and sometimes even for fighting where terrain is favorable. All types, in modern warfare, must be able to "take it."

At Aberdeen Proving Ground, laboratory tests provide engineering data on automotive components, while field tests determine the capabilities of the complete vehicle under field conditions. After data on engine horsepower, transmission losses, efficiency of parts and of the complete vehicle, are obtained, then come the more spectacular, outdoor tests. Draw-bar pull and draw-bar horsepower, power losses, resistance to traction, and other characteristics of vehicles are obtained by use of a field dynamometer. The accelerometer for recording time and distance traveled, is another valuable instrument used. The photographs show some of the more obvious tests, with various types of vehicles passing through the water and mud courses, over the cross-country course at high speed, up and down the slope course. The sand course and the concrete washboard course (not shown) also supply valuable data.

Track-laying units balk not at mud, though handicapped with wheels in fr
as was the case with this half-truck car in the soupy mud of the mud cou

Severe punishment: a 75-mm gun carriage being whirled on the merry-go-round of the circular cobble-stone course



Scout cars must be tough—and powerful. This one climbed a 60 percent grade, the steepest on the slope course

Proving that a depth of 18 inches of mud is no fit highway for a truck. This powerful military truck stuck tight in the mud course at that depth

attaching the vehicle to the rear draw-bar of the dyna-
at various speeds by instruments that are carried

AMATEUR SEISMOLOGY

Half Amateur, Half Professional . . . Constant Battle . . . Listing the Difficulties . . . No Royal Road to this Scientific Hobby . . . Work . . . Work

By ALBERT G. INGALLS

A RELATIVELY new field for the demi-scientist or half amateur, half professional, is earthquake recording—amateur seismology[1]. Now that engineers, architects and insurance men have found that it will pay in dollars and cents and human lives to build up an applied earthquake science, and not leave seismology entirely to the purely theoretical or pure scientist, the need of establishing stations all over the earth, in order to learn just how the earth shakes, has become evident. Seismology is still a young science.

In November, 1929, this magazine published an article entitled "Amateur Seismology" and in it a small seismographic instrument was described. That instrument was designed for recording local, rather than distant, world-wide shocks, yet quite a number of our readers made copies of it, and among these was Mrs. M. M. Seeburger of Des Moines, Iowa, whose photograph is shown on the opposite page. "But," Mrs. Seeburger writes, "because of its impracticability in a non-seismic area such as Iowa, I soon abandoned it in favor of teleseismic instruments." Teleseismic instruments are seismographs which record distant earthquakes.

RECENTLY, Mrs. Seeburger was invited to write an article about her present equipment and station, called "the Des Moines Seismological Station," but she felt that her connection with seismology had not been long enough to justify her writing a signed article about it. However, the present writer, also being interested in seismology, thereupon asked Mrs. Seeburger a number of written questions, and the replies to these questions constitute a sort of interview which is in many ways more readable than a formal article would be. Mrs. Seeburger writes:

"I am pleased to know that you are interested in the construction of the instruments used in the Des Moines Seismological Station. Their development has been a task full of problems, and also thrills. Constructing an instrument is a good apprenticeship for any one adopting seismology as a vocation or an avocation. There is seldom a repair man just around the corner when a seismograph gets temperamental and it is necessary to know your instrument from the ground up, or rather from under the ground up. I am still learning about mine and discovering new ways to improve it.

"MY instruments are modified Bosch-Omori in type, with both components (north-south and east-west) recording on one drum. Each component consists of a horizontal pendulum pivoted on an upright set in a reinforced concrete pier which extends three feet below the floor of the basement seismograph room. The upper suspension consists of fine piano wire attached to bolts in each side of the heavy mass, and extending from the top of the upright. The heavy mass, a 24 kilogram lead cylinder, is adjustable along the boom of the pendulum, which is made of 3/8-inch pipe. The wire suspension at the top of the upright is adjustable from right to left by means of a screw, so that the position of the pendulum may be shifted to correct the tilt which accumulates with temperature changes. The angle of the top suspension can also be adjusted to regulate the period of the pendulum, which in my instruments is nine seconds; that is, a complete free and undamped swing of the pendulum requires nine seconds.

"The customary lever magnification system has been abandoned in these instruments in favor of a silk thread and spindle device, which reduces friction but requires a great deal of attention and a very delicate touch to keep in perfect adjustment. A steel rod, attached to the end of the boom by a three-way adjusting device, ends in a U-shaped fork, having a needle eye at the end of each tine. The fork moves in the same plane as a clock wheel, mounted on a pinion, working in jeweled bearings in a frame, the wheel being between the points of the U. A groove is cut in the rim of the wheel and a fine silk thread connects the two needle eyes, passing once around the groove in the wheel. The thread must be kept at unvarying tension and operating in the exact plane of the wheel, else sensitivity is lost. Riveted to the wheel is a recording arm of very light aluminum, ending in a fork with a very light arbor set in polished bearings. The arbor carries a balanced stylus which has just enough weight to remain on the smoked paper. The Des Moines instruments magnify the earth movement 15 times.

"THE drum, 13 inches long and 8½ inches in diameter, is turned by a power clock by means of a sliding clutch device, with a lead screw at the opposite end of the drum from the clock. The drum makes one revolution per hour. The drum is mounted on a reinforced concrete pier three feet in depth. Smoked paper is used on the drum, the stylus marking its record on the smoked paper as the drum revolves. Both components record on the same drum, one pendulum being parallel to and one at right angles to the drum.

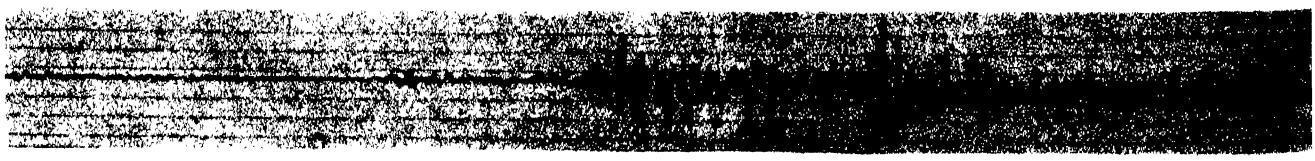
"Time control is provided by a very good regulator clock, which closes an electric circuit every minute, operating an electro-magnet over the drum, lifting the styli for three seconds, leaving a gap in the record from which time can be computed.

"An oil damping device prevents the pendulums from continuing their swings and complicating the record."

Interesting as was the above communication, it did not cover some questions which the readers of this magazine

[1]The correct pronunciation is sis-mology, "sis" rhyming with ice. Often mispronounced.

A seismogram from one of Mrs. Seeburger's first rec



might be likely to ask. Therefore the next letter to Mrs. Seeburger asked the following questions: "What did the entire equipment cost to make? What special difficulties, if any, did you experience, and what results did you get from the seismograph? Can you, for example, record the distant quakes mentioned daily in the newspapers —those in Japan, South America and so on? How did you get your design? How would a reader go about getting a start as an amateur seismologist? Have you a scrap of record made on this particular seismograph which you can spare, for reproduction?"

Mrs. Seeburger's reply:

"Your letter finally caught up with me in Iowa, after pursuing me throughout the west for several weeks. Now for your questions.

"I did not keep a record of the cost of my instruments and station equipment. It did not exceed 150 dollars, but I could not duplicate it for that, so that figure might be rather misleading. The most expensive items are the power clock for driving the recording drum and the regulator clock which governs the time marks on the grams. These I bought at a bargain from a bankrupt jeweler, else my expense would have been more. I did my own cement and foundry work, but employed a machinist and also a watch maker for work on some parts of the mechanism.

Science Service photo

Mrs. Seeburger of Des Moines with the seismograph she designed and built, and which she operates

"LISTING the difficulties would fill your magazine. Reducing friction to a minimum in every adjustment and bearing, yet without allowing any lost motion, is a constant battle. A movement of the earth amounting to .01 to .001 millimeter must be recorded, and this is impossible unless every bearing is kept perfectly polished, every adjustment perfectly made, and the whole magnifying and recording system so lightly made and delicately balanced that even the tip-toe step of a tiny child inside the doorway of the seismograph room causes the needles to quiver.

"I had a great deal of trouble working out electric circuits to record minute marks on my grams. A circuit must be closed every minute, operating a magnet which lifts the needles for four seconds, thus leaving a gap on the record. The problem was to devise an electric circuit strong enough to lift the needles, but not strong enough to stop the clock on the contact, and using contacts of a material that would not readily burn out. My contacts are of platinum-iridium, and a 1½-volt dry cell is used for power.

"Then the seismograph room had to be specially equipped for keeping the temperature uniform. These are just a few of the many problems.

"Results have been very satisfactory for low-magnification instruments. I recorded the Quetta, India, shock, more than 10,000 miles away, also one in North Africa, last spring, as well as closer ones in the Aleutians, Mexico and various parts of the United States. I enclose a blue print of one of the first earthquakes I recorded. It originated in Lower California, distance, approximately 1400 miles.

"However, no stations, even those with the most expensive and intricate instruments, record daily quakes, except perhaps in highly seismic localities where there are occasional series of local shocks. Of teleseismic records the best one can hope for is two or three shocks per month. Often there is only one. For this reason, as well as because of the expense of installation and upkeep and the large amount of time required daily to keep the instruments in successful operation, I doubt whether teleseismic instruments will ever be popular with amateurs.

"The amateur astronomer can study the stars two or three or four nights a week, when it is most convenient, but the seismologist must be on the job every day and every night, changing records, figuring shocks when any occur, and 'trouble shooting.' He is as bad off as a young mother nursing a pair of twins.

"LEARNING to interpret the records of distant shocks is also an intricate study. I tear out another handful of hair every time I try to compute the distance of a new type of shock—afraid I will disgrace myself by reporting a shock several thousand miles from where it happened. Of course the exact location can only be determined at some headquarters receiving reports from a number of stations; for example, the United States Coast and Geodetic Survey or the Jesuit Seismological Association. A single station can only determine distance and sometimes direction.

"How did I get my design? I visited most of the stations in the western half of the United States. Then I read all the nice (?) easy literature you mentioned, and some German books in addition. It all went over my head, and I had to back up and start over. I still re-read that literature every six months, and each time manage to absorb some new facts. Eventually I decided on a Bosch-Omori type as the simplest for a beginner, and grafted thereon a number of ideas from other instruments—experimented and discarded and experimented some more—filled a ton or so of paper with computations on friction and damping. Dr. Neumann, Chief of the Division of Seismology of Geodetic Survey, to whom all my reports are sent, has given me much helpful advice.

"The instruments I use are designed for teleseismic recording, that is, the recording of distant shocks. A strong local shock would dismantle them.

"I think any of the seismologists are glad to encourage amateurs in the field, provided they will put in the time, money, study and continuous work necessary to establish and maintain accurate and dependable stations."

rthquakes. Its origin was 1400 miles from her station

New Caissons Speed Work

By R. G. SKERRETT

"GYRATING" caissons are the latest aids to the foundation engineer in providing proper support for massive buildings where a satisfactory footing can be reached only many feet below the ground surface.

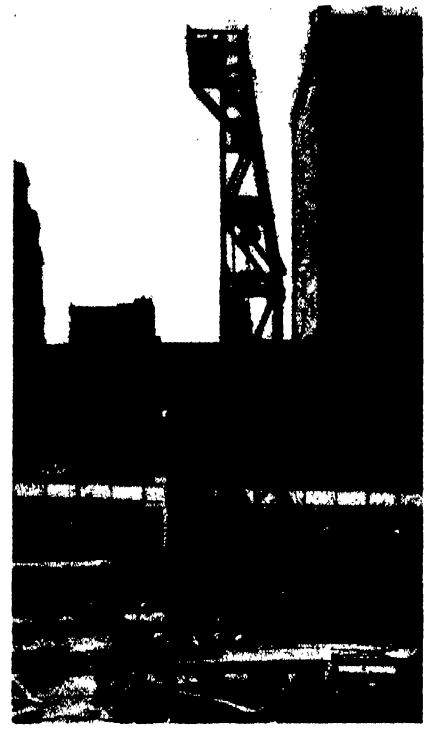
Caisson sinking is necessarily a more or less protracted operation, depending upon the nature of the ground penetrated and the depth to be reached; "sand hogs" are paid high wages because of the hazards of their occupation. To effect economies and to do the necessary work quickly, gyrating caissons of large diameter and of an average length of 60-odd feet have been utilized recently to provide the essential underpinning for the new Federal Office Building in New York City, which is to occupy an entire city block. To give it suitable support, the contractor was called upon to construct an underpinning, reaching to bedrock, and made up of no fewer than 112 separate concrete columns or a corresponding number of groups of steel and concrete piles. Preliminary borings, made at different points of the site, disclosed the presence of boulders that would obstruct the driving of piles. The bedrock slopes and has an uneven surface, and it lies from 65 feet to 70 feet underground. For 50 feet down, the ground is sand, followed by layers of clay, gravel, hardpan, and a bottom stratum of quicksand just above the rock. Boulders up to several feet thick are embedded in the deeper layers of the formation.

Tungsten-carbide coated teeth on the caissons resist the great wear

The caissons were steel tubes from 4 to 8½ feet in diameter, with walls ⅜ inch or ½ inch in thickness, and the cylinders averaged 66 feet in length. The cutting edge, in each case, was a ring of heavier steel that carried great teeth arranged like a rip-saw, and those surfaces of the teeth most exposed to wear were made more resistant to the abrasive action of the ground by coating them with a film of tungsten-carbide. When stood upright for sinking, the top of the caisson was sealed with a headplate through which passed one or two connections for a corresponding number of water jets that had their outlets a short way above the cutting edge. During sinking, each caisson was guided by a head frame 78 feet tall; at the front of that tower there was a car on which was mounted a horizontal gear wheel driven by an electric motor of more than 100 horsepower. The gear wheel could be turned at a rate of from 4 to 11 revolutions a minute, and this rotating mechanism could be locked to the headplate of the caisson so as to spin the latter. The car carrying the rotating apparatus was suspended like an elevator, and was raised or lowered by an electric hoist placed upon the platform at the rear of the tower.

WHEN a caisson was lifted upright and set in position for sinking, the dead weight of the caisson forced its cutting edge into the ground and sealed that end of the cylinder. With that done, the caisson was partly filled with water by its jet or jets, and then the rotating machinery was started. As the saw-like teeth cut their way downward, water was discharged continually by the jets so as to over-balance the pressure of ground water and to maintain a continuous outward and upward flow of water from the caisson. Fully 70 percent of the material that entered a caisson was disposed of in that way. The water jets operated at a pressure of 100 pounds per square inch.

The majority of the caissons were driven to bedrock and deep enough into the ledge to seal them there so that their headplates could be removed and the gravel, hardpan, and pieces of rock remaining could be lifted out with grab buckets. In some of the caissons, where



A caisson part way down, showing the car and one of the water lines

the irregular surface of the bedrock or its slope interfered with the complete sealing of the cutting edge when rock was reached, the cylinders were equipped with air locks, put under pressure, and "sand-hogs" then went down into them to clear away the remaining material preparatory to placing a concrete seal. The concrete seal shut out ground water and formed the first bond between the bottom of the caisson and the supporting rock. Subsequently, those caissons, as well as all the others, were filled to their tops with concrete, and on those solid columns or piers was laid the foundation for the walls of the great structure.

To sink pneumatic caissons of the same dimensions in ground of a similar nature, to corresponding depths, would have required, so it is said, anywhere from six to eight days for each caisson. The gyrating caissons made their journeys downward at speeds varying from 12 feet to 20 feet an hour, depending upon the resistance offered by the ground and the size of the caisson. Even the presence of ground water, reached almost at the very start of the operations, due to the proximity of the site to the original Hudson River shore line, did not slow up the sinking of these newly developed aids to the construction engineer.

ENERGY FROM THE SUN

Step by Step Solar Engines Increase in Efficiency ... May Reach Economical Level as a Power Source

IN the June number, 1935, we published a photograph of the improved solar cooker developed by the head of the Smithsonian Institution, Dr. C. G. Abbot. Since that time Dr. Abbot has once more changed the design and raised the efficiency of his solar heat concentrator, and there is now some actual promise that, with a few more such increases, solar heat, as an ordinary power source, may enter the market in competition with the one source of energy which we now find most generally efficient, all things considered; that is, coal.

Dr. C. G. Abbot has made various experiments in the last 20 years as a contribution to the age-long problem of using solar heating for power, cooking, and other purposes. His studies have culminated in an efficient machine.

The energy of the sun's rays which would fall at sea level on a cloudless day on a square yard of surface at right angles to the rays, turned completely into mechanical work, would slightly exceed one horsepower. But many losses occur. Of these the greatest single one results from Carnot's theory of the perfect heat engine. It is shown that the greater the range of temperatures employed, the greater the efficiency. Hence the effort has generally been to reduce heat losses and concentrate solar rays, so as to raise a very high working temperature in the solar engine.

BUT this hitherto has involved large and costly heat collectors and associated apparatus. Though solar rays cost nothing and are available to at least 1000 times our total present consumption of coal, oil, and hydroelectric power for all manufacturing, heating, and lighting requirements, solar power has hitherto been unable to compete economically with these other sources.

Dr. Abbot's improvements lie first in the cheap yet accurate and efficient ray-collector employed, and second in the highly efficient and heat-saving absorber for the collected rays. He employs a parabolic cylindrical mirror of Alcoa sheet. This comes in large sizes as a flat, thin sheet of very light specific gravity, reflecting over 80 percent of solar rays, and so permanent in surface that a year's exposure to the weather produces no appreciable deterioration. A simple metallic framework of aluminum and duralumin makes up a cradle of the exact parabolic curvature required. He prefers the curve whose equation is $y^2=30x$. To this frame the metal sheet may be screwed down without previous forming. Experiment shows that the present unit mirror with a two-foot wide sheet about six feet long will bring the sun rays to a focal line no wider than a lead pencil.

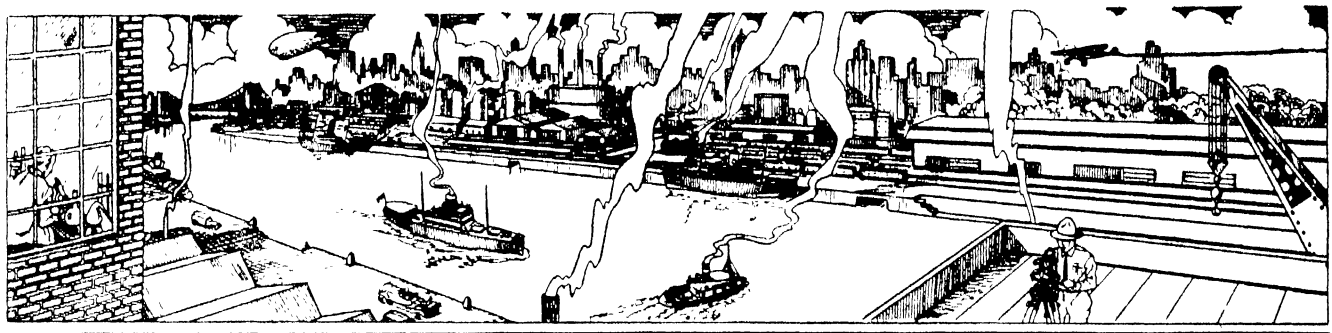
Dr. C. G. Abbot and his latest sun's ray collector, a more efficient energy source than any previous model

At the focus the rays pass through two concentric tubes of Pyrex glass 1¼ inches and ⅞ inch in diameter respectively, till they reach a central ½-inch Pyrex tube, metal plated on the top third of its circumference, and within which flows a black liquid called Aroclor. This liquid is a chlorinated diphenyl compound made by the Monsanto Chemical Co. With the addition of a very little lampblack it almost totally absorbs the focused solar rays, and though still liquid when reduced to ordinary temperatures, it does not boil or flash at 350 degrees, Centigrade (662 degrees, Fahrenheit). A high vacuum is maintained between the tubes so that heat is lost only by radiation, as in a Thermos bottle.

A flow of the liquid is maintained either by gravity circulation or by a pump. Thus the heat absorbed from sun rays is carried away to the apparatus for steam power (such as a tubular boiler), for cooking (such as a reservoir with inserted ovens), or for evaporating liquids (such as an open coil).

Experiments and theory agree in promising an over-all efficiency of 15 percent for steam power production. This contemplates a boiler at 382 degrees, Fahrenheit, so that its maximum theoretical thermodynamic efficiency is about 40 percent. Losses by reflections, inefficiency of steam engine and so on, bring the final figure to 15 percent. This is a very substantial improvement on previous sun motors. Ackermann, in "Utilization of Solar Energy" (Smithsonian Annual Report, 1915), claims 183 square feet per brake horsepower as the best output of the solar power station of "Eastern Sun Power Ltd." near Cairo, Egypt, in 1913. It is computed that with equal sun intensity the Abbot machine will require but 60 square feet per horsepower. Ackermann goes on to claim practical equality in economy with coal at £3 10s per ton. If so, the present machine could compete with coal at £1 3s per ton, if the relative costs of the machines are equal. But here again there is a marked saving in the greater simplicity of present construction.

A half-horsepower steam-raising model is in construction. Whether a substantial proportion of the world's power demands will be taken on by sun power within a few years is doubtful, but it is believed that if it were required, the power field might be filled by sun power at little if any advance in costs with present appliances. This would, of course, require co-operating storage of power. The most obvious, though very costly, method is through the storage battery. Another is by pumping water to a reservoir on an adjacent hill or mountain and recovering power from its fall. A third is by chemical synthesis of active agents, as by the decomposition of water. A fourth has been suggested in which heat itself is economically stored.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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Treasure

SOME time ago we published a discussion of the Metallascope, a so-called treasure finder operating on well known radio principles. This instrument is fully portable, weighing only 22 pounds, and is easily carried by an operator over ground

The "treasure finder" in use

which is being investigated for hidden bodies of metals, either in the ore or bullion state. It is interesting to note, according to a recent letter from Mr. Gerhard R. Fisher, who developed the instrument, that a few months ago a large amount of gold, silver, and copper, said to be valued at 14,000 dollars, was found with one of his instruments at the Tumacacori mission in Arizona.

Still a Puzzle

TEETH may decay in spite of a completely adequate diet, it is shown by experiments at the College of Physicians and Surgeons of Columbia University. Tests lasting three years contradict the theory, widely held in both scientific and lay circles, that tooth decay is caused by a dietary deficiency.

"The practical significance of this finding is that, while we know it is possible to reduce the amount of caries or dental decay by improving the diet, we now know that we cannot prevent decay completely by this method," said Dr. Theodor Rosebury, assistant professor of bacteriology, who conducted the research. "The reason for this is that a deficient diet is a modifying influence rather than the primary cause of caries, which still remains virtually unknown."

Dr. Rosebury fed five generations of rats "a fully adequate diet." Over a period of three years, the rats continually developed caries. "This result," he explained, "checks with human experience to the extent that we know the disease occurs in human beings healthy in all other respects and giving evidence of adequate nutrition. We can produce caries more rapidly with diets deficient in mineral elements. But no matter how adequate we make the diet, dental caries is still produced."

FIVE MILES—ONE POUND

A PIECE of nickel tubing has been produced with an outside diameter of .005 of an inch and a wall thickness of .0008 of an inch. Each linear foot of this tube weighs .000046 of a pound and it would take more than five miles of it to weigh one pound.

Gasoline Prices

WHILE a great many technical improvements have been made recently in the manufacture of gasoline, the motorist continues to pay about the same price for his fuel. As R. S. McBride, writing in *Chemical and Metallurgical Engineering*, points out, this is due to economic conditions over which the technical man has no control. The objective of the gasoline maker is to put a high-grade motor fuel into the motor-car tank at the lowest feasible cost for material, labor, capital charge, and distribution expense. Unfortunately, the greatest attention on the part of the public is directed toward the second or third of these items, which are the smallest in actual importance to the motorist when he buys his gasoline. There is a great commotion over new processing methods; and there is quite a hubbub from time to time about competing materials. However, the chemical engineer processes all the raw materials so efficiently that the labor and capital charge involved are probably less than a quarter of the average tax paid to states on each retail sale. Hence in today's retail price, tax is the biggest factor, distribution expense is second, raw material cost is third, and the processing expense is a poor fourth in the price burden on the motorist. Improvements in processing will come, but they cannot revolutionize the pump price of the gasoline.—*A. E. B.*

Telescope Glass for Cooking

ASTRONOMY and cooking marched hand in hand during the three years' research which led to the development of the ultra-low expansion type of glass that was used in the great 200-inch diameter disk of glass for the new telescope of California Institute of Technology.

An item from *Science Service* states that astronomy obtained the disk for the telescope mirror out of investigations in which 1500 different kinds of glass were studied.

A glass dish with removable handle to be used for top-of-stove cooking

Housewives will benefit from the same work, for one of the new glasses is now being used for a new type top-of-the-stove glass cooking utensil.

The new style glassware has a still lower coefficient of expansion than the well-known oven glassware already manufactured by the Corning Glass Works. The new glass, which can be placed right over a flame on the stove, is designed to supplement rather than replace the present oven-type glassware.

What makes ordinary glass crack when heated suddenly or unevenly, indicates Dr. J. C. Hostetter, who had charge of making the great telescope disk, is the large coefficient of expansion which sets up unequal stresses that finally pull the glass apart.

For glassware used directly over a flame, the minimum coefficient of expansion is a desirable characteristic, but it must be coupled with other factors such as mechanical strength and length of useful life.

For the great telescope mirror disk, low expansion was also a major requirement. Thus the search for the proper glass had the two objectives, with astronomers and the housewife jointly benefiting.

44²

THE title of this note is simply another way of writing the year 1936, for this number is an exact square of 44. This is the first time since 1849 that the year has resulted from a perfect square, and it will not happen again until 2025 A.D.

Diagnostician for Automobile Ills

IN the same manner that a physician uses his instruments to check the functioning of a human body, an automobile mechanic may quickly and accurately determine the condition of a motor through the use of the Ford laboratory test set.

The battery is the first object of investigation where a complete inspection is made. Strength of the individual cells is recorded on a three-volt meter. The same meter is used to show a defective ground strap or loose ground connection. Leads are connected at each side of the ground connection and resistance set up by a poor connection shunts the battery current through the three-volt meter. Thus a low reading means good conductivity and a high reading, poor connection.

Cable and cable connections from battery to starter switch are checked in the same way, by cutting in a 15-volt meter. After all starter connections are checked, a test of the starter motor is made to determine its amperage draw.

Instruments that find car troubles

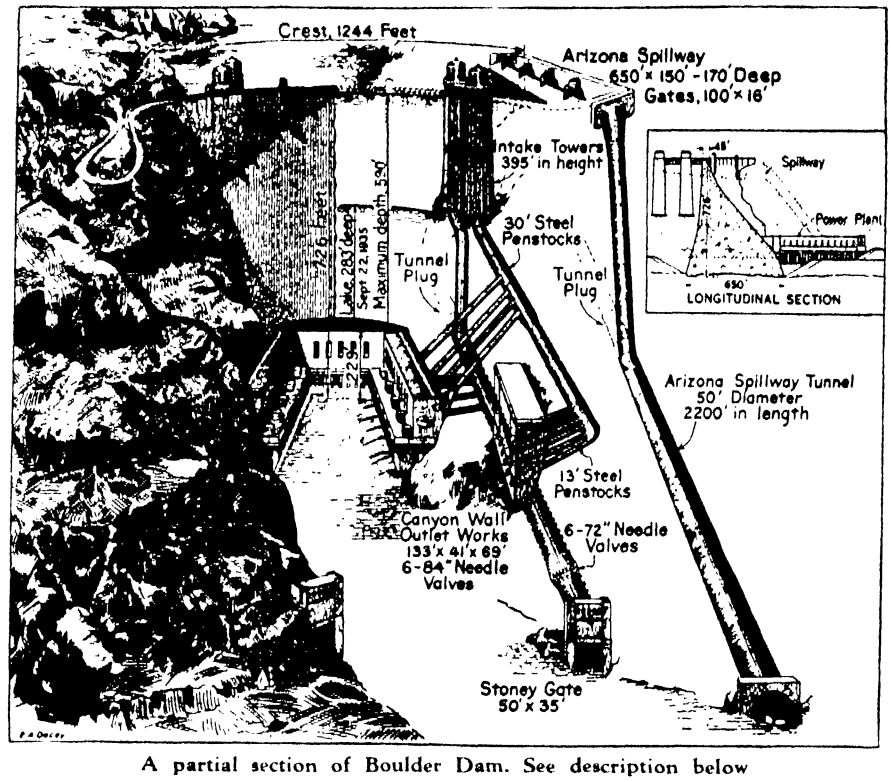
This test will show low battery voltage at the starter, poor brush contact on the commutator of the starter, a shorted armature, bent shaft or tight bearings. The test is made by connecting a high-reading ammeter to the hot and cold sides of the starter switch and noting the readings, while the engine is running.

The compression test, made by recording the pressure in any cylinder on the compression gage, will reveal defective piston rings, defective valves, or gasket leaks. Normal compression on the gage shows everything is all right. Low compression, when brought up to normal by oil sealing the pistons, shows loss of compression past the piston rings. Low compression not brought up to normal by oil sealing the pistons shows valves are in poor condition or gaskets leaky.

Examination of the primary ignition circuit includes tests for freedom from shorts, condition and spacing of distributor points and breaker arm spring tension.

The secondary ignition circuit is tested by spark gaps which are adjusted to the engine compression reading. Provision is also made for testing the condenser.

Proper fuel flow is checked by testing both the fuel pump vacuum and pressure. The test set not only checks the carbureter but furnishes a means for quickly making a correct adjustment. The generator is checked for condition, charging rate, and output voltage.



A partial section of Boulder Dam. See description below

Schematic of Boulder Dam

HOW does Boulder Dam work?

This question has been asked innumerable times. In an effort to explain the workings of the dam the accompanying drawing, with the Nevada wall of Black Canyon remaining solid, and the Arizona wall cut away to reveal the intake towers, the spillway, the penstock pipe, and outlet works, has been made by E. A. Dacey, chief draftsman of the Bureau of Reclamation staff.

For the convenience of readers the dimensions of the dam and its appurtenant works are given on the drawing.

A small longitudinal section has been inset on the drawing for the purpose of showing the thickness of the dam at its base and at its crest. This inset also will illustrate the relative position of the intake towers and the spillway to the power house and dam.

Inside the Nevada wall of the canyon a similar set of penstock, diversion, and spillway pipes has been placed.

It will be noted that all the diversion tunnels, constructed to carry the water of the river past the dam site during the construction period, have been used for at least a part of their length in the permanent construction. The two spillways lead by a sloping incline into the two outside diversion tunnels, which have been plugged upstream from the juncture. One of the penstock pipes on each side is carried for the major part of its length through the inside diversion tunnels, which also have been plugged.

The penstocks, it will be noticed, feed the turbines in the powerhouses through branch pipes, and continue down stream to outlet works emptying directly into the canyon below the dam.

The spillways are safety valves. They have a combined capacity of 400,000 second-feet. It is not probable that they ever will be used, but they stand ready in case of emergency. The largest recorded flood on the Colorado reached a maximum of approximately 250,000 second-feet. However, before records were kept a flood which may have reached a height of 300,000 second-feet occurred. Should even this latter flood pour into the reservoir when it is brim full, it would not tax the spillways or use more than three

quarters of their capacity. It is not contemplated that during flood seasons the reservoir will be allowed to remain brim full. The big floods on the Colorado always occur in the spring when snow begins to melt in the mountains, and they can be foreseen. However, as an added precaution, the penstocks themselves can be used in time of emergency to dump an additional 100,000 second-feet of water past the dam.

Thus, a total capacity of 500,000 second-feet is provided in the spillways and penstocks, a capacity twice the greatest recorded flood.

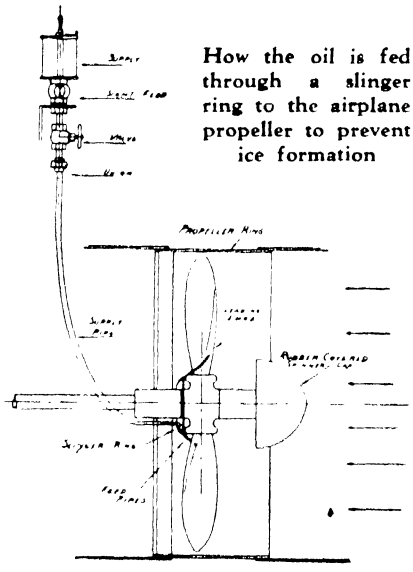
MAPS

DESPITE the fact that people are now more map-conscious than ever before, not more than 47 percent of the United States has been completely mapped to show elevations and slopes. In this respect, Dr. William Bowie of the Coast and Geodetic Survey says that the United States is one of the most backward of all the highly organized countries of the world.

De-Icing the Propeller

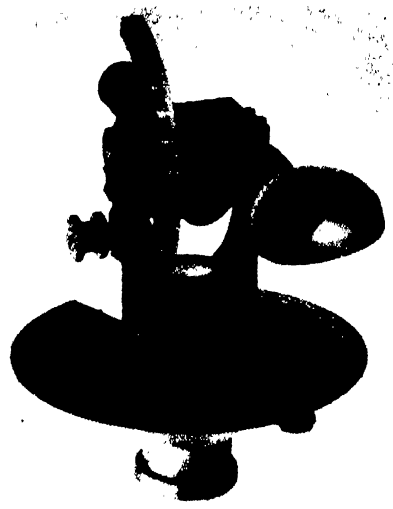
As our regular readers already know, the Goodrich company has been responsible for the development of airplane wing de-icers, sometimes known as "overshoes," which have added much to the safety of flying. The ice hazards of flying, however, were not entirely eliminated thereby; there still remained the problem of de-icing the propeller.

In some of the first experiments, the propeller spinner was covered with rubber to break the continuity of ice across the hub, and oil-saturated rubber was applied to those portions of the blade on which ice formation was likely to occur. The de-icing oil minimized the adhesion of the ice to the propeller and allowed centrifugal force to throw it off in small particles. With the advent of geared engines and slower speed propellers, however, these precautions no longer sufficed.



How the oil is fed through a slinger ring to the airplane propeller to prevent ice formation

Now, with the co-operation of the Bureau of Air Commerce, and T. W. A. Airlines, the Goodrich company has developed a system of continuously feeding a de-icing compound to the revolving blades; the experiments have been so successful that 60 "de-icing slingers," as they are termed, are to be installed on twin-engined Douglas airplanes employed by Transcontinental and Western Air.



Drift and speed indicator

Modern engineers and chemists no longer proceed by "cut-and-try" methods on actual full scale machines or equipment, but use laboratory methods first. Accordingly, a special refrigerated wind tunnel was employed in the initial experiments. The tunnel was surrounded with a refrigerated chamber and water spray was injected into the air-stream. A 2000-watt spotlight threw a beam to a mirror which was revolved by an electric motor. In the viewing mirror the propeller blades appeared to be at rest when the speeds of the revolving mirror and of the propeller were synchronized, and could be carefully observed.

The de-icing slinger is illustrated in one of our diagrams. From the de-icing fluid supply tank, a regulated feed system permits the fluid to flow through the supply pipe to the slinger ring. The fluid falls under gravity on a circular piece of felt which is kept taut by a circular coil spring. The fluid passes through the felt to the feed pipe which brings the fluid in contact with the leading edge of the propeller. Of course the supply pipe is stationary. The slinger ring, spring, feed pipe, and so on, revolve with the propeller.

Two main lines of attack have been followed. In one the propeller blades were covered with rubber and supplied with oil. In the second a mixture of alcohol and glycerine was fed to the bare aluminum blades.

While the first plan has the advantage that the blades continue to de-ice as long as the rubber retains any oil, there is too much labor in applying the rubber and the aerodynamic efficiency of the propeller is somewhat impaired.

With the second system, greater simplicity of installation is obtained and there is instantaneous shedding of the ice. The sole disadvantage is that de-icing stops immediately when the supply of oil ceases. It is the second system which has been adopted for use on the airlines.—*A. K.*

A Convenient Drift and Speed Indicator

The air-speed of an airplane is readily determined by the ordinary air-speed indicator, which is actuated by the pressure developed in the Pitot tube. But the air-speed is *not* the true speed over ground or sea, because it takes no cognizance of the wind speed. In flying over the ground, corrections may be made by sighting on landmarks, but in flying over sea the problem is more difficult. An artificial reference mark must be created by means of a smoke signal or bomb thrown into the sea. Then there must be available an easy method of sighting on the smoke signal.

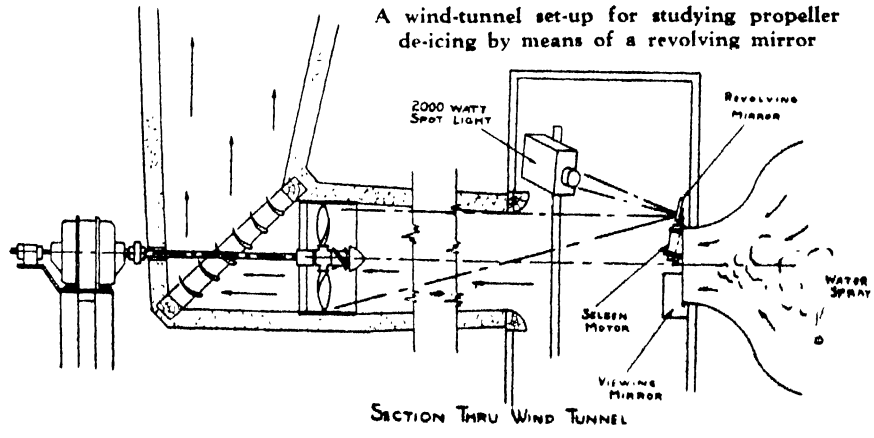
Pan-American Airways, whose operations are mainly over sea, has long made use of such smoke signals. The instrument used in conjunction with this signal is called a drift and speed indicator, and has appeared in many forms. The most modern, and one of the most useful of such drift and speed indicators, is that developed by the Kolsmann Instrument Company and illustrated in our photograph.

The drift sight consists of a telescope, supported by two standards, mounted for rotation about a vertical axis for measuring horizontal angles. These angles are determined by an index fastened to the standards and riding against a scale divided in degrees. The telescope can also be rotated about a transverse axis. Its elevation or depression is measured on the vertical arc.

The instrument is supported on a ball and socket joint and is leveled by a spirit level mounted in the center of the standards. The ball and socket joint terminates in a cylindrical shank which is fitted into a mounting bracket suitably disposed on the aircraft.

In fixing the sight into position, it is very important that the telescope should point exactly fore and aft when the index of the horizontal graduation is at zero. To achieve

A wind-tunnel set-up for studying propeller de-icing by means of a revolving mirror



this condition, a distant reference point is selected, and the airplane is turned into the direction of such point by sighting along the line defined by the rudder post and the propeller hub. Then the telescope is turned till the horizontal graduation reads zero. Only then is the drift sight fastened rigidly in place to the mounting bracket.

To determine the angle of drift or lateral motion of the airplane away from its fore and aft axis is quite simple. A smoke signal is dropped, and the telescope is pointed to the floating signal. The horizontal graduation, read immediately, gives the angle of drift.

The determination of the true speed over sea offers a little more difficulty. It should first of all be noted that the vertical arc of the instrument has a series of small notches cut on its edges, and these notches can engage with a small latch mounted on an arm fastened to the telescope axis. Immediately after the smoke signal has been dropped, the telescope is directed towards it. As the signal appears in the field of view, the telescope is elevated to engage the latch with the most convenient notch, so that smoke signal is still below the horizontal cross line of the telescope. Without moving the telescope from this position, the smoke signal will be seen to rise upward until it reaches the horizontal cross line. A stop watch is then started, and the telescope elevated to engage with the following notch. This will cause the signal to move back to the bottom of the field of view, whence it will rise again owing to the motion of the aircraft.

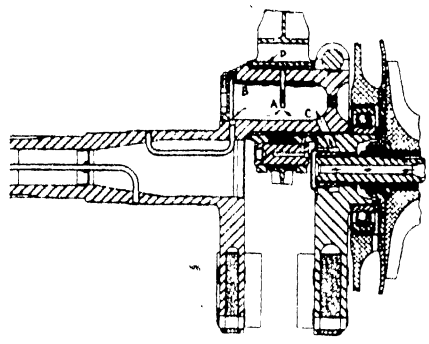
It is easy to see that with the notches appropriately graduated, with the altitude known from the altimeter, and with the aid of the stop watch, the true speed can be calculated. Since these calculations are a little troublesome, special alinement or calculation charts are provided for the pilot. —*A. K.*

Better Lubrication by Centrifugal Action

CLEAN lubricating oil is recognized as a vital necessity in aircraft engine operation, and oil filters and strainers are standard equipment. No precaution is too great to prevent foreign matter, which may have found its way into the lubricating system, from continually passing through the system and causing bearing wear. Naturally, one of the most vital points of a radial air-cooled engine is the master rod bearing. Here the prevention of excessive wear is of prime importance for dependable operation.

Crankcase and crankshaft of Wright Whirlwind engine after 400-hour endurance test with the centrifugal oil cleaner, showing the sludge removed by the separator

In the new Wright Whirlwinds and Cyclone engines a centrifugal separator has been introduced which will get rid of even very small particles. This new device is illustrated by the diagram. "D" is the master rod bearing mounted on a hollow crank pin. When the engine is in operation the lubricating oil enters this oil chamber through the inlet "C" under pressure at an angle of 45 degrees. Here centrifugal force created by the rapid rotation of the crankshaft, and acting in the same manner as the conventional cream "centrifuge," separates the heavier carbon particles and products of oxidation from the oil itself and deposits them on the walls of the chamber "B," in the form of a soft sludge cake. This mass collects around the base of the tube "A," but it is only the clean lubricating oil that passes through "A" to the master rod bearing. A removable plug at the rear of the crank pin provides for the cleaning of this sludge at overhaul.



Cross-section of engine crankshaft and master connecting rod. The letters are referred to in the text

The effectiveness of this new centrifugal separator was proved by a recent 400-hour test with a Wright Whirlwind 285-horsepower engine. After the test it was found that the master rod bearing remained in perfect condition with its surfaces smooth and polished in appearance. When the plug was removed from the crank pin and the oil pocket cleaned, more than two ounces of sludge were removed. —*A. K.*

Higher Performance with 100 Octane

AIRCRAFT engines of high compression ratio and with superchargers cannot operate at full throttle near sea level with ordinary aviation gasoline. They either exceed the permissible cylinder temperature of 550 degrees, Fahrenheit, or develop "knock" and roughness, or even cut out suddenly.

Prior to 1928, Army Air Corps engines operated with fuels of about 50 octane number. At present, fuels of 92 octane have been made economically possible. Anticipating a need for a 100 octane fuel, the Air Corps purchased 1000 gallons of "iso-octane." This, blended with a sufficient quantity of aviation gasoline, gave the fliers 2000 gallons of 100 octane fuel.

Tests with the new fuel on pursuit airplanes, powered with Wright Cyclone engines, gave an almost miraculous increase in power. With the 92 octane, the Cyclone could develop only 610 horsepower without trouble. With the 100 octane fuel, the power could be readily increased to 800 horsepower.

It can be seen how desirable from a military point of view (and from a civil aviation point of view, for that matter) is this tremendous increase in power with relatively little increase in weight. There is no doubt that the expense of iso-octane will go steadily down, and that the high octane fuels will little by little displace all other gasolines for aviation use, with a corresponding increase in speed and economy of operation.—*A. K.*

A Modern Airport Beacon

AIRWAY beacons have constantly improved in effectiveness since their inception. The most modern, and in many ways the most complete in function, is the General Electric 36-inch "Bartow" beacon illustrated in these columns.

The rotation speed of 6 per minute, the mechanism for rotating the beacon, the 1000-watt, 30-volt lamp, and the automatic lamp changing mechanism call for no special comment. What is novel is that the spherical beacon is almost entirely "lens" and incorporates three types of beams in the one beacon.

From the photograph it will be seen that the main beam is produced by a "doublet lens" placed to the right in the picture. The doublet lens gives a high candle-power beam concentrated to a small angle in both vertical and horizontal planes.

A new revolving airport beacon provided with three lens systems

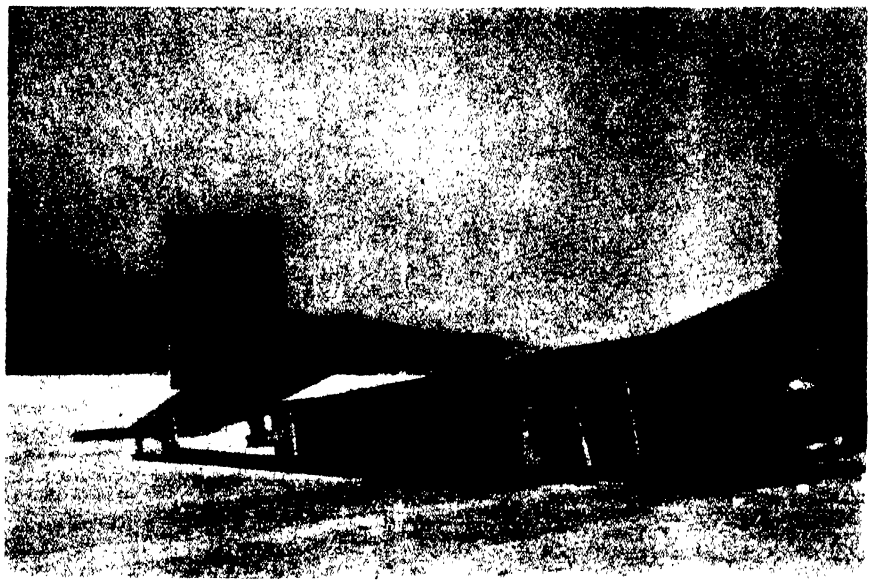
To the left is a spherical Fresnel lens which produces a lower candle-power beam of small vertical divergence but covering 270 degrees horizontally. This Fresnel lens is tipped to the axis of rotation and so produces a wobbling effect in the sky.

On top of the beacon is a ceiling lens, tipped at the same angle as the Fresnel lens, thus also giving the upward beam a distinctive motion, with a giant cone of light traced out in the sky.

On the airways the addition of green or red color screens inside the beacon will indicate "landing" or "no landing" locations and help to eliminate the use of course lights.

What are the purposes of this combination of lenses and "tipped" positions?

First of all there is continuous visibility which prevents eyestrain by permitting the eye to be focused on the beacon at all times. Second, there is distinctive charac-



Side view of rocket plane, showing the fuel tanks

terization; the beacon cannot be mistaken for just a light. Next there is long duration of flash, which every pilot appreciates. The upward beam, besides giving distinctiveness, may be used as a "ceiling" height indicator.—*A. K.*

Automatic Flight

We have often had occasion to refer in these columns to the Sperry Gyropilot. There are now over one hundred Sperry Pilots flying the fastest ships on the airways. Another device to which we have drawn attention is the Kreussi Radio Compass, built by the Fairchild Company, which permits the pilot to take bearings on any radio station he can tune in.

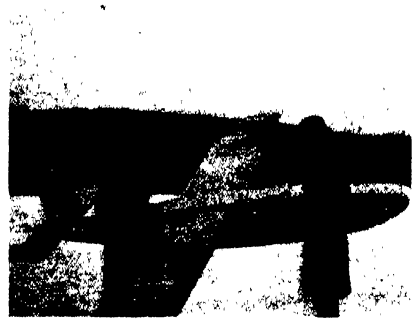
In a lecture before the New York Electrical Society, P. R. Bassett, of the Sperry Company, announces that the Army Air Corps is now trying out a combination of the Gyropilot and the Kreussi Compass. The airplane will then fly automatically towards any station tuned in, and will also be able to fly automatically along any airway radio beam.

Such automatic navigation has great possibilities. *A. K.*

Airmail by Rocket?

An unsuccessful but noteworthy attempt to send airmail by rocket plane was recently tried between Greenwood Lake, N. Y. and Hewitt, N. J., a distance of some three miles. The rocket was to carry mail, with full authorization of the Post Office Department, and beautiful stamps had been specially printed for the flight.

The wing and tail surfaces of the rocket mail plane were built of duralumin. The wing span was 25 feet and the fuselage was 11 feet long. The rocket motor was mounted in such fashion that the thrust or reaction passed through the center of gravity. A catapult was to be employed to launch the rocket plane into the air, at the same angle as the subsequent climb under the power of the motor, but in the trial flight, the plane did not take to the air. The motor contained no moving parts and there was no propeller. Two tanks were mounted within the fuselage; one contained liquid oxygen, which at the instant of evaporation has a



The experimental rocket mail plane ready for its unsuccessful flight

temperature of minus 200 degrees, Centigrade, and the other contained a mixture of alcohol, gasoline and methane. A third tank contained nitrogen under pressure which was utilized to drive the oxygen and the fuel into the combustion chamber, which was a simple cylinder with a nozzle for the release of the gases.

Once the fuel was electrically ignited in the oxygen vapor, combustion should have continued for some 30 seconds, the products of combustion issuing rapidly from the nozzle providing the necessary thrust by simple reaction.

The undertaking was encompassed with many difficulties, in the motor itself, in the stability of the rocket airplane, and so on, and the final trials were greatly hampered by the intense cold at Greenwood Lake. Regardless of the failure of the first flight, the undertaking is of real technical interest, and the results add just that much more data to the files of the rocket proponents. *A. K.*

Bomber versus Pursuit

In aerial warfare, there is a constant change in the relative power of offense of the single seater pursuit and the defensive power of the bomber.

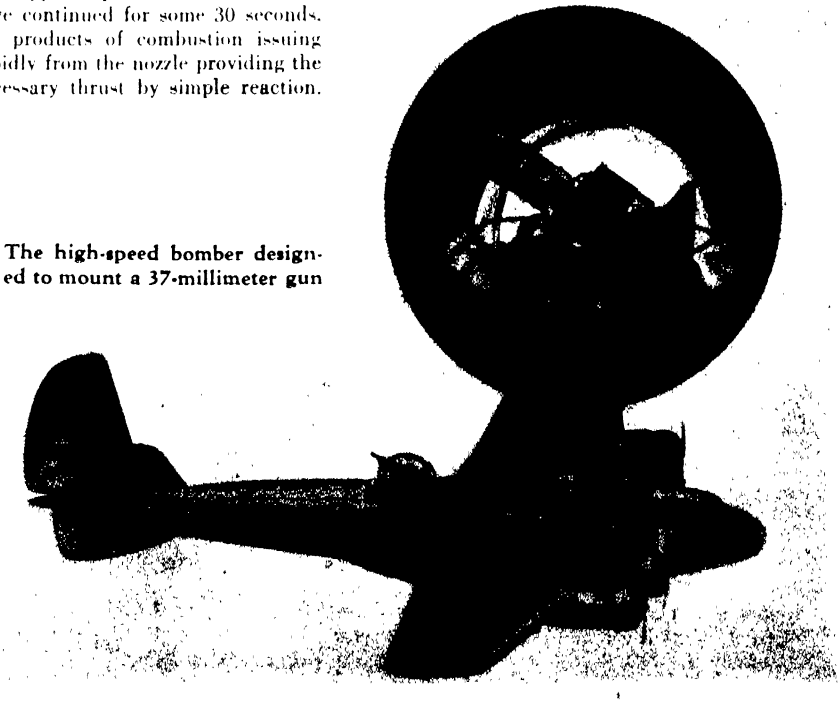
In 1917 the speed of the pursuit exceeded the speed of the bomber by approximately 50 percent. With its greater maneuverability, the pursuit, therefore, had all the better of the argument.

To-day the bomber will do 250 miles per hour; the fastest pursuit does not reach 300; so the speed superiority of the fighter has largely disappeared. But the bomber carries machine guns which are only accurate and effective up to 200 yards range. The pursuit has, therefore, been equipped with 20-millimeter cannon effective up to 500 yards and more. Again the pursuit has become more deadly.

What is the counter-weapon? The installation of still more powerful weapons on the bomber—a 37-millimeter (1.4567 inch) cannon with an effective range of 1000 yards.

So the temporary superiority in fighting of one type and the other will probably continue to swing back and forth.

The new 37-millimeter cannon has been developed by the American Armament Corporation, and is perhaps the most powerful weapon ever mounted in an aircraft. Not only is it more effective because it carries a larger charge, but it is also large enough to handle projectiles which will burst at any pre-determined range. This prevents the projectile from injuring personnel if it should drop in friendly territory during actual warfare.



The high-speed bomber designed to mount a 37-millimeter gun

The new gun is mounted in the rear cockpit of the bomber, as shown in the photographs, and is capable of 360-degree rotation, 15-degree depression, and 60-degree elevation. The only restrictions on this zone of fire are those imposed by the location of the wings, fuselage, and tail surfaces.

The gun is mounted in a special shock absorber so that recoil is restricted to a factor low enough as not to affect the equilibrium of the airplane. An elaborate series of tests in the wind tunnel at New York University were also made to balance the gun aerodynamically and make it easy to move when exposed to the air stream. Its construction is as light as possible, thanks to the liberal use of aluminum alloys.

These modern aircraft guns are a far cry from the Army revolvers with which enemy aviators used to salute each other harmlessly at the beginning of the World War. —*A. K.*

Coupe for Private Flying

THE Curtiss-Wright coupe is the latest model to be delivered to the Air Commerce Bureau as part of its program for developing airplanes suitable for private flying. The coupe has attracted much favorable comment and embodies many features attractive to the private owner and amateur pilot.

As a two-seater with a 90-horsepower Lambert engine, the new airplane has a top speed of 131 miles per hour and a cruising range of 580 miles with a gasoline capacity of but 50 gallons. Although the wing loading is moderately high—10.1 pounds per square foot—the stalling speed is only 44 miles per hour, thanks to the use of a split flap. The wing area is 173 square feet, the span 35 feet and the over-all length 25 feet 2 inches.

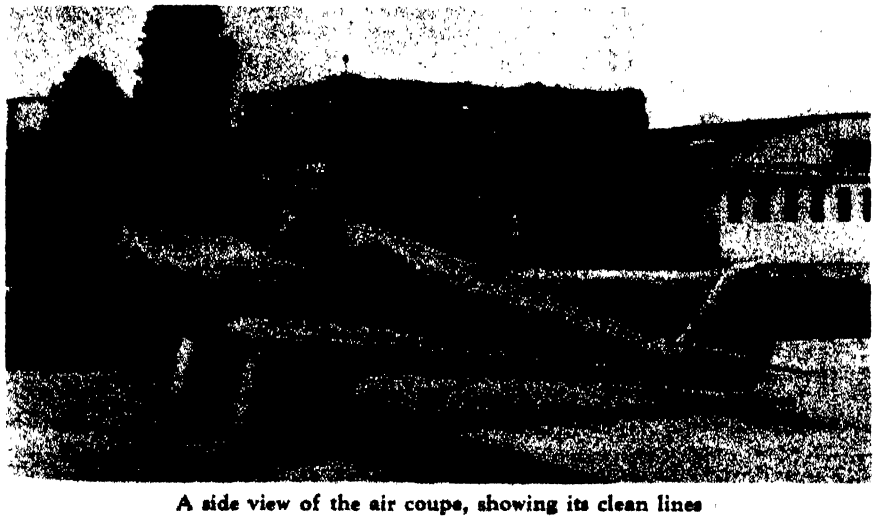
If the lines of the new airplane are examined, it will be found to be as clean and aerodynamically modern as the very latest of our airliners—there are even control tabs on the elevators. This is undoubtedly the right line of approach. Private owners want safety but they also demand aerodynamic efficiency and high speed.

Another feature which makes the Curtiss coupe so much like a miniature airliner is the all-metal construction. The wings are all metal, of the full cantilever type, with a dural skin designed to take a full share of the load. The fuselage is of the "semi-monocoque" type with a metal skin riveted to longitudinals and stringers, with rings or bulkheads at intervals.

Looking into the cockpit of the new two-place coupe for private flying

Perhaps the most praiseworthy aspects of the design lie in the vision and passenger accommodation. With a low position of the engine, sloping windshield, side windows, and transparent roof, the vision is excellent in all directions. The Curtiss engineers have proved that it is *not* necessary to have recourse to a pusher machine with engine in the rear to secure such adequate vision. The vision is further enhanced by a feature long familiar in automobile practice, but not often resorted to in plane design; namely, the provision of two rear view mirrors in the two automobile type ventilators placed in the roof of the cabin. These ventilators provide "no-draft" ventilation, with the air drawn in through a duct in front of the engine and discharged through the top of the cabin.

The interior of the coupe has been "cleaned up" to the extent of providing a control arrangement which does not require a stick between the passenger's knees. Of course, the idea of the control wheel projecting from the instrument board is not new, but in this case it has been so well worked out as to be considered worth continuing on the production models. Actually, there is a conventional column at the head of the instrument board, placed in an inverted position, to which the wheel shafts are connected. The wheel to the right is fitted with a disconnecting device which renders the wheel inoperative when a non-flying passenger is carried. The foot pedals, which are of the automobile clutch and brake type, may likewise be disconnected on the right side, in which case they lie flat against the floorboard, so that the passenger may have additional foot room. —*A. K.*



A side view of the air coupe, showing its clean lines

Air Camera for Amateurs

IN recent years as air travel has become more common, many passengers on air transports and owners and pilots of private planes have carried aloft cameras with which to snap pictures of their own homes, as they passed over them, or scenes which they wished to record. Such air photography for the amateur has not always been a complete success for it is often difficult to do good work from the air with an ordinary camera. To fill this need, there has now been developed a camera for the amateur built especially for aerial photography.

This new camera is built into a one-piece aluminum case which gives it strength without undue weight. Its streamlined design reduces wind resistance and a large handle insures a firm grip. It is equipped with an f/4.5 lens, and incorporates a built-in aero filter that insures sharp negatives through haze. As an integral part of the case, there is a new type brilliant finder which gives a large, upright image. Using standard 3¼ by 4¼ Supersensitive Panchromatic film pack with 12 exposures, it is easily loaded in flight. Its total weight is three pounds and 11 ounces, and its length is 7½ inches.

The air camera for amateurs may be operated with one hand, while retaining complete control of plane

Washington Award to Charles F. Kettering

CHARLES F. KETTERING, vice president of General Motors Corporation, in charge of research, has been elected from a field of 26 candidates to receive the Washington award for 1936. Affectionately known to his associates as "Boss Ket," his agile imagination and bold attack on technical problems have won him recognition as America's Number One researcher and "monkey-wrench scientist."

This award is made annually when deserving candidates are found, as "an honor conferred upon a brother engineer by his fellow engineers on account of accomplishments which pre-eminently promote the happiness, comfort, and well-being of humanity." The winner of the award is pre-

sented with a suitably inscribed bronze plaque mounted upon a marble base. The commission is composed of 18 members, representing the American Society of Civil Engineers, The American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Western Society of Engineers.

Mr. Kettering receives the award as an outstanding engineer who has rendered preeminent service in promoting the public welfare through his outstanding contributions to the increase of personal mobility and his driving force for the cause of research as an instrument to increase the welfare and happiness of mankind.—*A. E. B.*

Scent in Lipstick Causes Skin Trouble

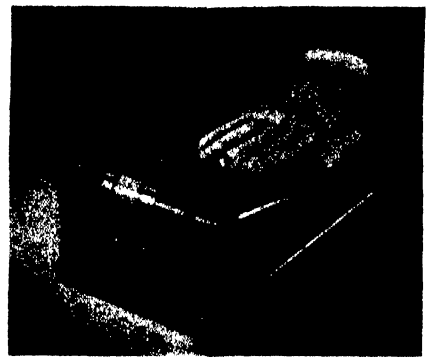
GIRLS should change the scent of their lipsticks if the kind they use brings on a skin trouble. Doctors have traced some cases of lipstick dermatitis—the skin disorder that occasionally develops among users of a lip rouge—to the perfume it contains. A particular offender is a perfume containing methyl heptine carbonate, *The Journal of the American Medical Association* states, according to *Science Service*.

A young woman came to her doctor with a breaking out on the skin, which he traced to her use of lipstick. She had been using a certain brand for years with no ill effects until she changed shades. By patch tests on the girl's arm, the physician found that she was sensitive not to the oil or dyes in the rouge but only to the perfume used in two shades of lipstick of the brand she had been using.

The same test was made on 38 other women. Exactly half of the 38 were sensitive to the lipstick that had methyl heptine carbonate in its perfume. Other possible components of the perfume used in lipsticks gave no reaction.

Gloves Fitted Scientifically

GLOVE-FIT, a new device which measures hand sizes accurately and gives finger lengths in terms of glove sizes, is now being distributed to retail glove counters



Determining glove size mechanically

throughout the country. This new instrument, housed in a lustrous Bakelite molded case, was designed especially for Gates-Mills, Inc., by Prof. A. C. Davis, who is consulting engineer and a member of the engineering faculty of Cornell University.

When a person's hand is inserted through the metal strap, the middle finger pushes against a movable button as far as the stops between the fingers will permit. After this simple operation, the sales clerk turns the adjustment knob until the metal strap is tightened firmly against the hand. Both hand width and finger length are registered on the instrument's dial.

336-TON NERVE SYSTEM

A NERVE system consisting of 110 miles of electric cable weighing 336 tons will be installed on the San Francisco-Oakland Bay Bridge. It will carry electricity to provide 8,000,000 lumens of sodium vapor lighting.

Gadolinium Isolated

THE rare element gadolinium, never before isolated in its free state, has been prepared 98.4 percent pure by French chemists who have devised a new method whereby the metal is obtained during electrolysis in the form of a fusible alloy which is easily dissociated in a strong vacuum. The operation may thus be performed at low temperatures. Cadmium, with a melting point of 320 degrees and a boiling point of 775 degrees, is the alloying metal chosen.

The electrolysis is carried on at a temperature as far removed as possible from the melting point, with fluorine contained in a carbon crucible which serves as anode. The cathode is a mixture of fused salts (gadolinium, potassium, and lithium chlorides) into which the current enters by a revolving rod of molybdenum. The current is seven to eight amperes at 10 volts and the operation lasts 15 minutes. The alloy, which contains 6 percent of gadolinium plus a little lithium, is distilled in a quartz tube under 0.001 millimeters of mercury at 1235 degrees, Centigrade. The tube is cooled under vacuum and filled with carbon dioxide gas. The resulting metal contains 98.4 percent metallic gadolinium and 0.7 percent silicon, but no cadmium.—*A. E. B.*

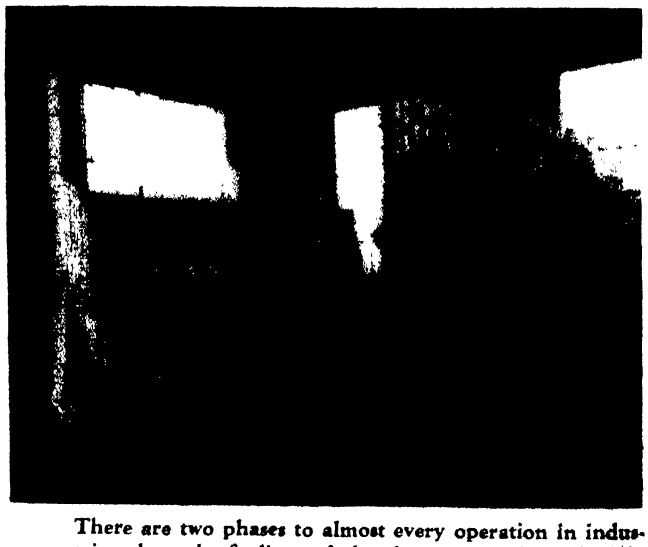
Admiral Mahan

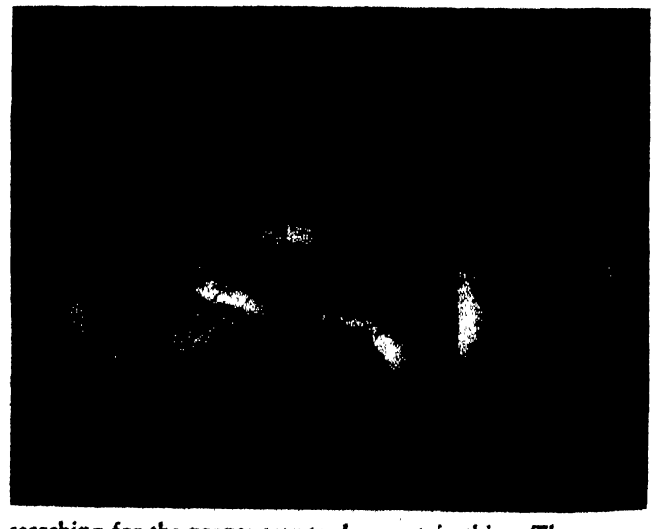
"AT the request of the family of the late Rear Admiral Alfred Thayer Mahan, I am undertaking to write his biography. It will be appreciated if any readers of the Scientific American who have any letters or other documents concerning Admiral Mahan will allow me to read them. I would also appreciate any well authenticated anecdotes concerning Admiral Mahan. (Signed) W. D. Puleston, Captain, U.S. Navy, Director of Naval Intelligence, Washington, D.C."

Strip for Double Glazing

NOWADAYS as air conditioning progresses and more attention is being given to house insulation problems, there have been many attempts to double-glaze windows to reduce the waste of heat through these openings. One such system, which we described some time ago, contemplated the sealing in of a second pane to create a dead air space between the two. A new method just announced by the Dewey and Almy Chemical Company consists of the insertion of a second pane cut accurately to size and held rigidly in place by a strip of molded rubber compound.

The particular advantage of this system is that all the work may be done right on the job as it is only necessary to purchase





There are two phases to almost every operation in industries where the findings of chemistry are used. In the laboratory the chemist uses delicate test tubes and flasks, searching for the proper way to do a certain thing. Then the plant chemist goes about the same thing, as at the right, mixing the same substances in huge corrosion-proof tanks

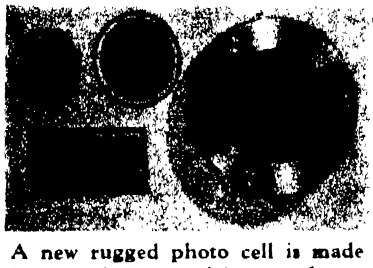
the binding strip in sufficient yardage and have the glazier cut a second pane of glass for each window. The one difficulty in the past has been to have this pane cut accurately as local glaziers are not ordinarily trained to do accurate work. This, however, is a problem which can be overcome by proper care. One further advantage of this process is that the added pane may be removed at any time for freeing the inside surfaces of the panes from any dust that may accumulate.

Chemical Estimates of Earth's Age

At a joint annual meeting recently of more than 500 geologists, mineralogists, and paleontologists, William D. Urry explained his work in measuring the life of rocks by their radioactive decay. By sampling a rock and applying the latest methods of micro-chemical analysis, Dr. Urry determines how much of the radioactive elements is still intact in the rock and how much has decayed, as indicated by the quantities of lead and helium which are the result. The rocks which make up the Palisades of the Hudson River are 150,000,000 years old; rocks near Duluth, Minnesota, were found to be more than 500,000,000 years old; while rock specimens from other parts of the world showed an age of 900,000,000 years. According to Alfred C. Lane, chairman of a special committee on the measurement of geologic time, these determinations indicated the age of the earth as a planet as not less than two billion years.—*A. E. B.*

Photo Cells for Many Uses

Available for the amateur experimenter as well as for the industrial engineer, a new photo cell of rugged construction may now be obtained in a wide range of sizes and in either rectangular or circular form. This photo-voltaic cell, known as Electrocell, consists of an iron plate on which is deposited a thin layer of photo-

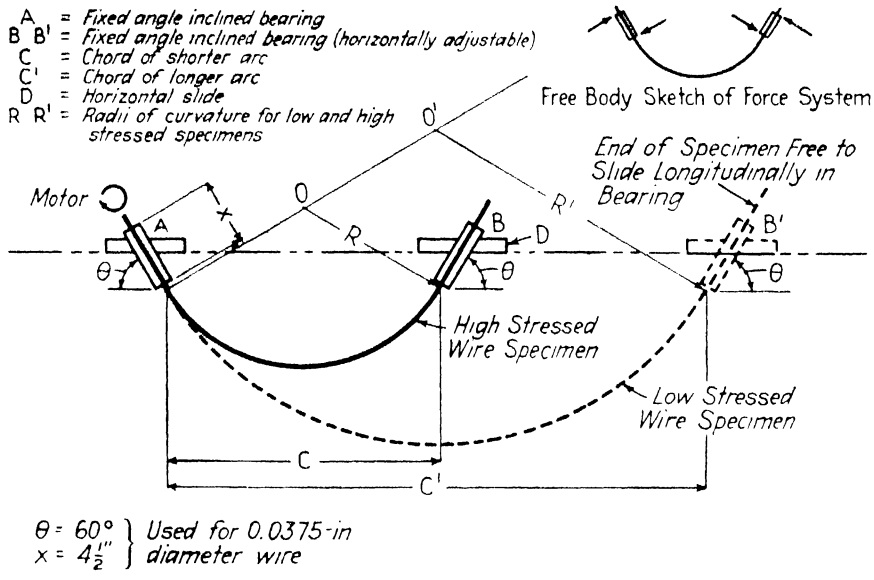


A new rugged photo cell is made in several sizes and in two shapes

sensitive material. This layer is protected by a coating of transparent lacquer, which renders the cell moisture-proof for all ordinary uses except in the presence of salt or acid, and makes it unnecessary to use special care in handling.

In direct sunlight these cells generate an e.m.f. of 0.6 volt, and the smallest of the elements, one inch in outside diameter, gives an output of 1.45 micro-amperes per foot-candle of illumination. At low light intensities the current is linearly proportional to the illumination, and in this range the current obtainable is approximately proportional to the active area of the cell.

The response of these cells to light variations is very rapid and the spectral range extends on both sides of that of the eye, going far into the ultra-violet. Temperature



The arcs assumed by a cable wire in the new device described below

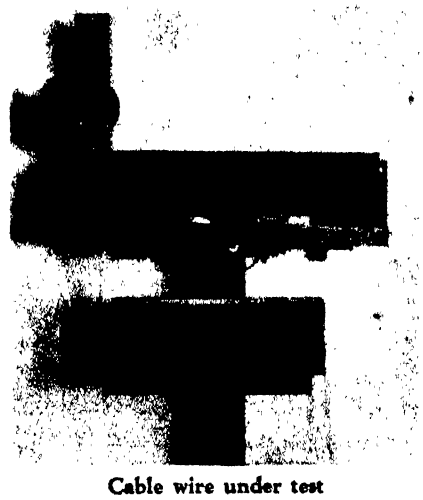
effects on the cell are practically negligible for all ordinary purposes.

It is possible to multiply the current output of these cells by connecting them in parallel. The rectangular shape lends itself to producing a photo-sensitive area of almost any size. The cells may be had mounted in casings with suitable terminals, or unmounted for use in special or experimental set-ups.

New Test for Cable Wire

A new method for determining the endurance limit of small diameter wire used in elevator and hoisting cable has been developed at the Engineering School, Columbia University, by John N. Kenyon. Heretofore a consideration of the fatigue limit of these wire materials has been to a large extent neglected because of the difficulties involved in making the fatigue tests. Wire rope specifications call for *static* tests (that is, tension, torsion, and cold bends) and, according to British investigators, give little indication of the true service qualities of these materials. Recent developments may lead to revision in present wire rope specifications.

The new fatigue machine is based on the mechanical principle that a rotating curved wire automatically tends to assume the form of a circular arc. Stress computations are



Cable wire under test

therefore very simple. The wire test specimen rotates at high speed and subjects the fibers of the outer curvature to a tension stress and the fibers of the inner curvature to a compression stress. When a fatigue crack once starts on the surface it is rapidly opened and closed until the wire breaks. The wire specimen is rotated in an oil bath to dampen vibration.

The machine is now being used to test wire of .024 to .050 of an inch in diameter used in typical wire rope fabrication. The test method may be used for much smaller wire and has theoretical application to lamp filaments.

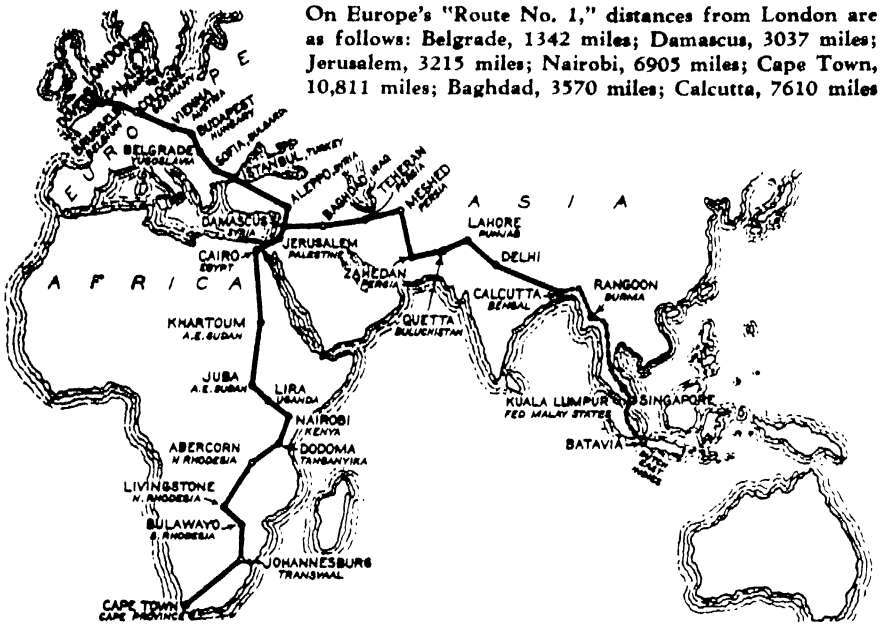
Caesar Not Born By Caesarean

Julius Caesar, contrary to widespread belief, was not born by means of a Caesarean operation, reports *Science Service*. Neither did he have anything to do with enactment of the old Roman law that forbade burial of a woman who died in pregnancy before the body of the unborn child had been removed by surgery.

The old myth about Caesar and his birth is exploded by Dr. John Harold Couch of the Toronto General Hospital and Herbert Newell Couch, assistant professor of Greek at Brown University, Providence, Rhode Island.

A reason for the persistent linking of Caesar's name with the operation is given by the Couches in the *Journal of the Canadian Medical Association*. The reason is quite the reverse of the traditional belief. Instead of the operation being named for Caesar, Julius Caesar's family probably got their name from it. The Couches explain it as follows:

"It is altogether probable that some distant ancestor of his was born by means of a Caesarean operation, performed on a dead mother, and the cognomen of Caesar, which is derived from the verb *caedo*, to cut, was attached to the newborn child for that reason. Another Roman family, bearing the name Caeso, may have derived their cognomen from the same cause. Such a method of assigning names would be entirely in harmony with the early Roman traditions. In fact, Pliny is the authority for this assumption, for in his 'Natural History' he re-



On Europe's "Route No. 1," distances from London are as follows: Belgrade, 1342 miles; Damascus, 3037 miles; Jerusalem, 3215 miles; Nairobi, 6905 miles; Cape Town, 10,811 miles; Baghdad, 3570 miles; Calcutta, 7610 miles

marks that certain people were born by an incision of the mother and that 'the first of the Caesars' was said to have been born in this manner."

Europe's "Route No. 1"

A PARTY of British and Empire delegates drove from London in a fleet of motorcars for the Budapest Conference on the Transcontinental Route from London to Istanbul, which has been called the European Highway No. 1. The Conference, which took place last fall, was convened by the Hungarian government, and aims at rationalizing the organizations existing in each country for the completion of this model highway traversing the whole continent of Europe.

The meeting was unique, for it marks the first occasion that a number of nations have collaborated in the construction of a truly international road, a map of which we have just received. It is reproduced here.

The idea of a transcontinental road was conceived by The Automobile Association of Great Britain in 1930 and adopted with complete unanimity by the Alliance Internationale de Tourisme. The project has received the enthusiastic support of the countries traversed. On two occasions—in 1933 and in June of last year—The Automobile Association surveyed the whole length of the route in collaboration with British car expeditions. Eventually it is intended that the route shall form the nucleus of a system of grand trunk roads extending across Asia to Calcutta and through Africa to the Cape.

Already a good deal of useful construction work has been accomplished along the European section of the route, which in its completed form will be a modern highway for all classes of traffic and not an "autostrada" for private motor vehicles only.

Helical Gears Used in Middle Ages

A HELICAL gear cut out of solid stone some eight or nine centuries ago, and bearing a striking resemblance to present-day helical gears, has been discovered in the ruins of an old castle in Sweden by Otto Lundell, President of the Michigan Tool Company. It is quite likely that the gear was one of a gear train used to drive a community grain crusher. Although the gear has outlived any definite records of the use to which it was put, it shows a startlingly clear conception of gear design for so ancient a period. Note, for example, that the gear is thicker at the hub than at the teeth, to provide adequate bearing area.

At the right for comparison is shown the latest thing in gears—the cone "area contact" worm gear.

Chemical Air Conditioning

CHEMISTRY has come to the assistance of the air-conditioning engineer by developing a simple, effective method of removing excess moisture from air. The conventional method of reducing the humidity is by cooling the air below its dew-point, generally to about 50 degrees, Fahrenheit. Then, in order to make the conditioned room comfortable, this air has to be heated again to about 70 degrees.

That's a foolish procedure and a waste of energy, said the chemist—I can show you how to remove moisture from air without cooling it. So he developed a process of passing moist air through a concentrated solution of lithium chloride, a treatment which will reduce the relative humidity to as low as 11 percent.

Lithium chloride has the present disadvantage of high first cost, but in almost every other respect it proves to be a highly satisfactory drying solution. Lithium chloride solution has proved in practice to be entirely stable, hydrolysis being entirely suppressed at the high concentration. It has relatively low viscosity, is relatively non-corrosive toward most structural materials, is unreactive toward carbon dioxide in the air, is non-volatile, and is entirely suitable for reconcentration by boiling in a commercially practical type of apparatus.

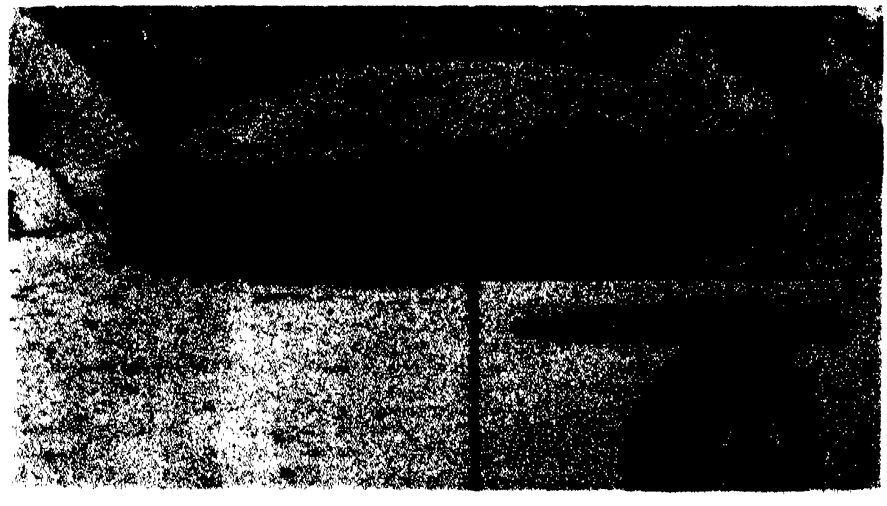
Apparatus has been developed whereby the moist air is passed through towers containing the lithium chloride, which soaks up the excess moisture like a sponge. Then when the "sponge" is saturated, the air current is automatically switched to another tower, while the first "sponge" is "squeezed out"—by concentrating the lithium solution—until it is ready to be used over-again. *—A. E. B.*

Septic Sore Throat Traced to Raw Milk

MANY cases of septic sore throat are directly attributable to drinking raw milk from infected cows, according to C. S. Bryan of the Michigan State College, as reported by *Science Service*. Investigation shows that as high as four fifths of herds tested which supplied one large city with milk were infected. In some herds only one cow had *streptococcic mastitis*, but as high as 26 percent were involved. These infected cattle constitute a grave menace to public health because of the contagiousness of the infection.

"Zam" Improves Zinc Plating

IMPROVED electro-plating of zinc is made possible by a newly developed anode material which has been introduced under the euphonious name of "Zam"—coined from the initials of its constituents—zinc, aluminum, and mercury. Zam is not attacked by acid or cyanide solutions until the current is applied. This makes it possible to have an anode free from sludge. No sludge on the anode means no anode polarization. Therefore, practically no increase of voltage will be required at any



A stone gear of the Middle Ages, and a helical gear of today

time. This permits setting the rheostat at a required point with complete assurance that the desired amount of zinc will be deposited in the given time.

When ordinary zinc is used as the anode, a higher voltage is necessary to obtain the required current density, as the anode coats over the decomposed zinc. The higher pressure results in more hydrogen being included in the deposit and, therefore, heavy deposits become brittle and non-adherent. The absence of hydrogen in the deposit, on account of the ability to plate at high current densities and low pressure, makes it possible to obtain a ductile, adherent deposit that can be easily formed without danger of cracking or abnormal distortion. *A. E. B.*

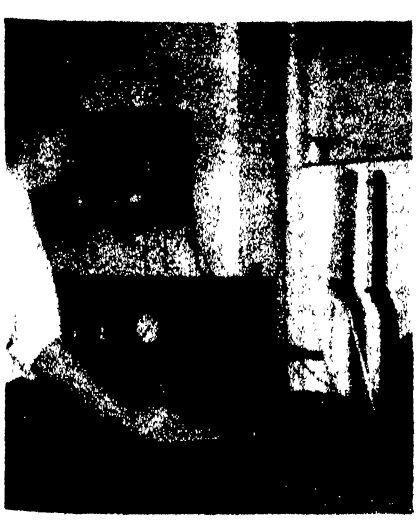
Single Picture Stereoscope

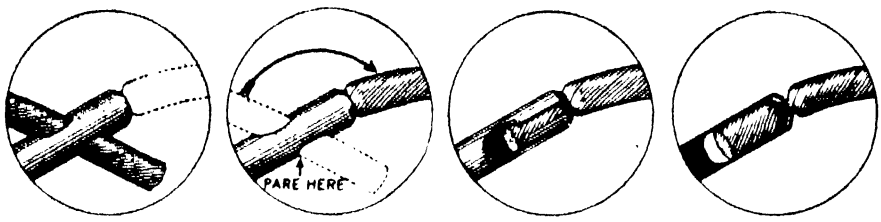
PICTURES and photographs appear real only if viewed with the help of the stereoscope. The necessity of stereoscopic pairs of pictures restricts the use of this fascinating device, very popular a few years ago.

It has recently been found by the Nu-Mirror Company that plane mirrors placed at a slight angle give an enlarged, brilliant, undistorted image of any single picture or transparency, regardless of the size, with such perspective that one has the illusion of seeing the original instead of a pictured copy. The large image in relief reflected by this optical instrument represents the incomplete fusion of two smaller and slightly different images, each image seen with each eye separately. The single picture stereoscope, known as a stereo-mirror, resembles an ordinary hand mirror and lends itself to a variety of optical experiments. Every detail of X-ray films, for example, also can be studied with much more accuracy than by looking at them directly.

Rethreadable Surgical Needle

IN certain delicate surgical operations, it is desirable to have a needle that can be rethreaded easily, and at the same time will make it possible to draw the suture material through the tissue without undue resistance. A needle that will answer these requirements has recently been perfected and is illustrated in one of our drawings. Various sizes are available for use with all





Steps in threading the new surgical needle, showing the suture firmly gripped

of the usual suture materials, which are locked firmly in place after the needle is threaded and the end of the material pared off. The result is that the needle and suture material are of very nearly the same size, making for more ease in operation, and less damage to the tissue.

Such needles are especially desirable in operations on ocular muscles.

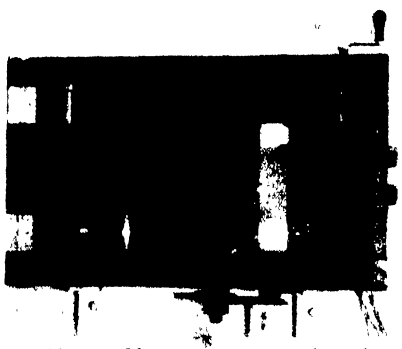
Measuring Minute Cement Particles

COUNTING and measuring cement particles so fine that they are invisible except through a microscope, is a daily routine in the research laboratory of the Portland Cement Association in Chicago.

A device known as a turbidimeter developed by L. A. Wagner at the National Bureau of Standards, is used in the process. This apparatus embodies a photo-electric cell, and the effects of particles as minute as 1 25,000th of an inch are measured in the following way:

A given quantity of the cement, the fineness of which is to be determined, is placed in suspension in a glass container filled with kerosene. Light passed through the container falls on the sensitive surface of the photo-electric cell, which actuates a micro-ammeter. As the cement gradually settles, the changes in the amount of light intercepted by the cement particles are indicated on the micro-ammeter.

The observer then makes a calculation



***Above:* Glass container and equipment for testing cement. *Left:* Making measurements on tiny particles**

from the dial reading by which he ascertains the surface area of the cement particles.

This procedure is a part of the constant research being conducted to determine the relation which the fineness of Portland cement bears to the strength of concrete.

"Optical" Rouge

OUR grandfathers sometimes think the world has gone to the bow-wows, because women nowadays are not stingy of rouge and cosmetics. But a historical study of the times of the 1700's, written by Mrs. Herbert Richardson, a Fellow of the Royal Historical Society, and published in the *Journal of the Royal Society of Arts*, shows that rouge is a thing that comes and goes, while the world goes right on. Writing of cosmetics in general she says: "We decry the vogue to-day for this particular folly, and yet the most highly colored of our modern 'bright young things' would be pale beside her great-great-grandmother. The beauty-doctor's posters were on every wall, her advertisements filled the newspapers, outnumbering those of any other type and purveying every requisite for beauty, even to 'the natural and lasting blush, not to be rubb'd off.'"

Women wore most elaborate head-dresses—erections of hair over some kind of light scaffolding and, says Mrs. Richardson, "Of course all this elaborate hairdressing could not be done every day. A head generally lasted three weeks before it was 'opened,' and nine weeks was as long as it could safely go in summer. One went to bed in a nightcap of the extinguisher variety, made of stiffened linen or pasteboard, or at any rate in a strong net fillet. According to contemporary art, a lady sleeping in all this artificiality of *coiffure* could still look delightful. But in actual fact, the discomfort of the craze, and the state of head with its powder and pomatum untouched for weeks, can only be imagined. An advertisement of 1777 shows, however, that it provided fresh work for the ingenuity of the silversmiths and jewelers: 'The many melancholy accidents,' it reads, 'which have lately happened in consequence of mice getting into ladies' hair in the night time, induced the Society of Art, at their last meeting, to offer a premium to the person who should invent the neatest and most useful bedside mousetrap. A silver trap is now invented by Mr. Moses Martingo, in New Bond Street, price 3 guineas. He also sells nightcaps made of silver wire, as flexible as gauze, and yet so strong that no mouse or even rat can gnaw through them. The caps are sold at 3 guineas each, but the *ton* have them of gilt wire from 6 to 10 guineas.'"

The male Scientific American reader who perhaps has been reading thus far aloud to his wife—anent women's foibles of course—may now read the next to the same listener, if his courage sufficeth. "The man of fashion rivaled his partner in folly, and much profitable trade went to his equipment. This was the era of the Macaroni, so called because macaroni was a special delicacy of Almack's, and the name got applied to the gentlemen who ate it there, and who, moreover, having traveled in Italy, knew how to do so."

This last no doubt explains the line in Yankee Doodle, which was written in 1753 by a British army officer in America—"He stuck a feather in his cap, and called it Macaroni." And now Mrs. Richardson continues: "Wool, at the advanced price, stuffed the great club of hair at their necks. The florists supplied the nosegay, which had to

be ever fresh; the goldsmiths its dainty holders. Men used rouge and paint fairly constantly, and during the Seven Years' War and other great wars of the period, the newspapers frequently advertised 'Campaign Boxes for Officers, fitted with eau-de-luce, rouge, perfumed pomatum, powder-puffs, lip salve and ivory eyebrow combs'—vanity boxes, in fact, for men."

The old-time score—men *vs.* women—evidently stood at about 50-50, and this old world survived thereafter.

Paper Crimping Machine

A BRITISH firm with representatives in New York has just developed an ingenious machine which would prove of value in most any office. This is a machine which will crimp documents together so

Paper crimper for small jobs

that they cling almost as tightly as though sewed, or will seal the edges of envelopes and do any number of jobs necessary in collating office correspondence or papers.

Clamped to the edge of a table or desk, this device is so arranged that its bed lies flush with the desk top. Papers to be crimped pass unimpeded between tightly meshed wheels with small, sharp cogs. The resulting crimp in the edge of the papers is similar to that produced by check protectors or like the crimp used to fasten the jackets of some cigarettes. This machine will crimp as many as four postal cards so that they cling together tightly.

Alnico—A New, Powerful Magnet

A NEW alloy, Alnico, so much more powerful than those commonly used hitherto as to open entirely new fields of application for permanent magnets, has been announced by the General Electric Company. Small motors, and various control devices hitherto operated by electromagnets, can now use permanent magnet fields, at a considerable saving in cost and greater simplicity of construction. Alnico magnets will lift about 60 times their own weight, when designed for that purpose.

Less than a quarter of a century ago the best magnets were of hardened plain carbon steel, developed by cut-and-try methods. Only a few years ago an alloy of iron, aluminum, and nickel was discovered to possess suitable permanent-magnet properties. This alloy contains no carbon and belongs to the precipitation-hardening type of alloys, quite distinct from the steels. The addition of cobalt was the next step; and thus was born Alnico. With the discovery that a precipitation-hardening alloy may possess excellent permanent-magnet properties, an entirely new field of alloys for magnets was opened for research.

The new magnet alloy has a relatively low specific gravity (6.9), is non-corrosive, and is brittle. It is cast in the proper design, and finished by grinding. Any necessary holes should be cored in the casting. Soft steel inserts may be cast in for fastening.—*A. E. B.*

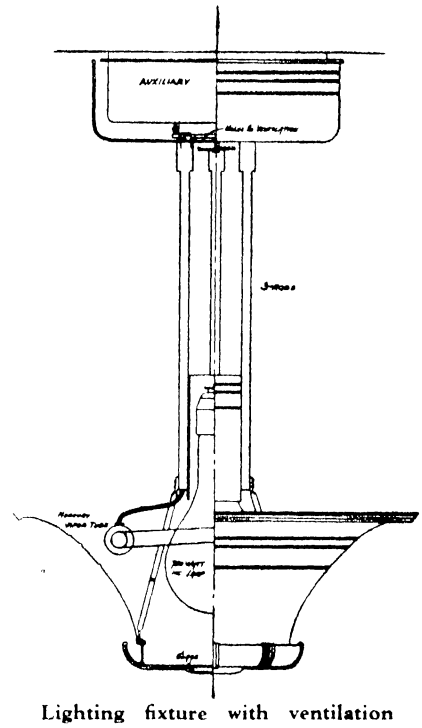
FREE SEEDS

MANY of us remember the old days when Congressmen passed out free packages of seeds to their constituents. Some people remember only too well, for Congressmen continue to be flooded with requests for these seeds. Don't ask for them; they are available no longer.

Windowless Building Features

IN our December 1935 issue we reproduced a photograph of the new windowless office building which has been built by the Hershey Chocolate Corporation. Since publication of that illustration, we have obtained some interesting comments relative to this building from Mr. A. Bowman Snavely of that company.

According to Mr. Snavely, the company felt that, because of the great development of air conditioning, it was only logical that a building of this sort should be put into operation. Such a building would eliminate the uncertainties of daylight and of weather. In the Hershey building, the light, temperature, and ventilation are unvaryingly and



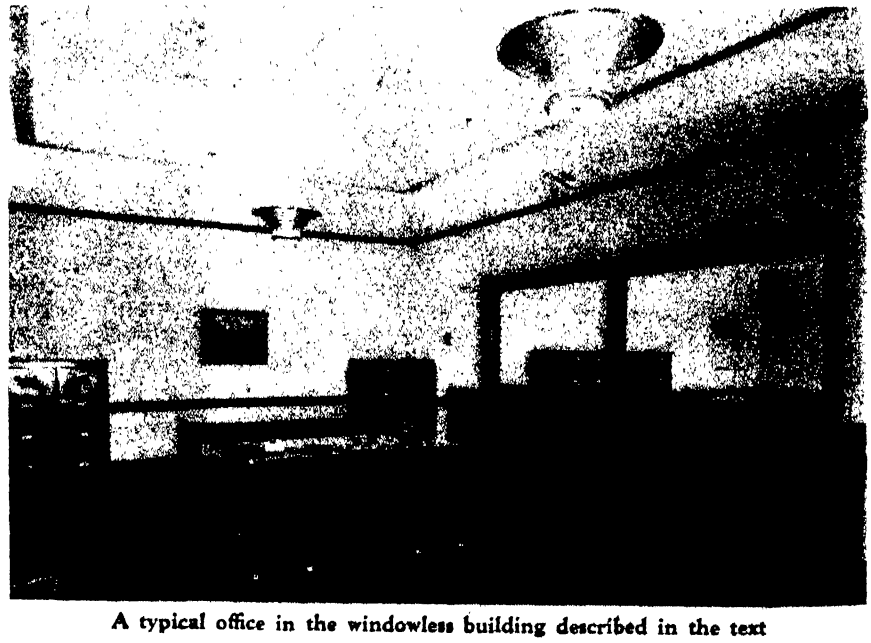
Lighting fixture with ventilation ducts used in windowless building

uniformly established at levels recommended as ideal for physical well being and efficiency.

Of the unique features, one of the most interesting is a weather signal system. Based upon the assumption that the only real reason for a window in a scientifically air conditioned and lighted building is to see what the weather is outdoors, the company installed a system of three colored lights under each clock in the general offices to reveal the outdoor weather conditions in a prearranged code.

One distinct advantage is that all the offices can be grouped on the basis of functional routine without consideration of window area or any question of which employee is entitled to an "outside" room.

Complete acoustic treatment has been given throughout. Ceilings are of Armstrong Corkoustic and this material is finished in ivory acoustic paint which retains the acoustic properties and yet has a high light



A typical office in the windowless building described in the text

reflecting value. Naturally, all external noise is excluded but acoustic treatment was necessary to prevent the feeling of constriction which might result if office noises were echoed from blank walls.

A very important consideration was, of course, the lighting system. Ordinary incandescent lamps are admittedly considerably overbalanced toward the red end of the spectrum in comparison with daylight, so that these alone would not do. Blue-glass bulbs or filters would act to reduce this overabundance of red, but this method is a "subtractive" one which seriously reduces the lighting efficiency. Accordingly, it was decided to use a light unit which combines the light of incandescent lamps with that of mercury-vapor tubes. In this way was produced an "additive" color balance of high visual and electrical efficiency, closely approximating daylight in its effect. The two floors of the building, therefore, use 158 combination mercury-vapor incandescent luminaries produced by the Voigt Company.

This building has been in use only since December, hence no complete report on its benefits are available. It is believed, however, that working efficiency and morale will be considerably improved under the scientific arrangement of the various equipment in this building.

Aluminum Roads

"ALUMINUM and a specially developed tar are credited," says *Municipal Journal*, "with useful results in some road paving trials abroad. A contributor to a German contemporary reports that the addition of powdered aluminum to tar and bituminous surfacings has the merit of insuring high reflecting power, a commendable attribute in itself from a lighting engineer's standpoint. Highway engineers can take cognizance of the statement that the metal keeps or tends to keep the temperature of the surface considerably below the normal point, thereby putting a check upon softening in hot weather." *A. E. B.*

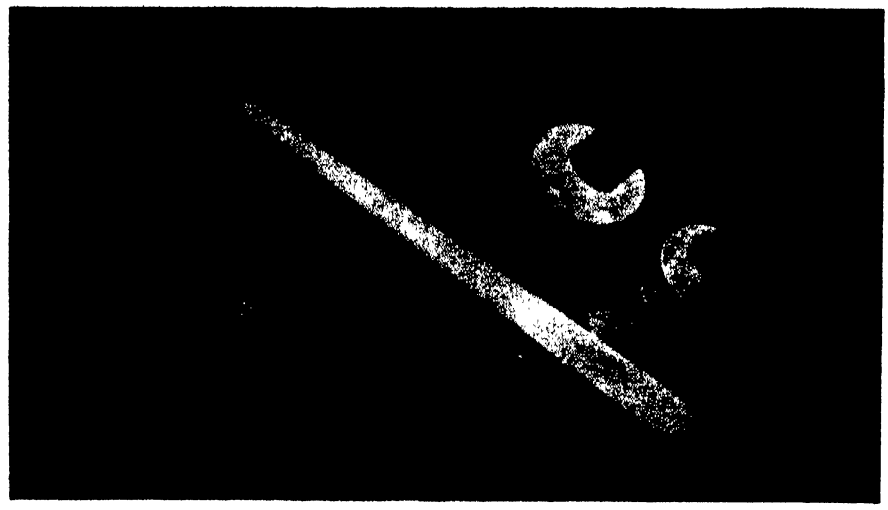
Glioma—Eye Cancer

DOCTORS Hayes E. Martin and Algernon B. Reese, of the staff of the Memorial Hospital for the Treatment of Cancer and Allied Diseases, New York, have reported on a new method of X-ray treatment of glioma of the retina in infants and children, which has not failed in six consecutive cases. Only two of these cases have finished the treatment; one of these children has now been attending school and keeping up in studies for over a year. The others are progressing favorably under treatment.

A notable feature of the method is that the eyesight is preserved, the eyebrows are intact, and only the eyelashes are lost. The doctors made it clear that their report was a preliminary one and that final results could not be proved fully until five years have elapsed.

Glioma of the retina is a form of cancer of the eye, which occurs in young children between the ages of two and five years. It is of congenital origin. It appears first in one eye, which is lost, and then often in the other eye, so that if the child survives, it is totally blind.

After many trials, the present method was



THE PASSING OF THE NAIL FILE

TWENTY YEARS AGO, the wise car driver carried a nail file to clean the platinum points in the distributor.

Today, the nail file is banished from the automobile tool kit. Tungsten points, developed in the General Electric Research Laboratory, in Schenectady, N. Y., have replaced soft and expensive platinum. There is little need to file tungsten points. Hidden away, requiring no attention, they break electric circuits half a million times an hour and save car owners millions of dollars a year.

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GENERAL ELECTRIC

THE FINGER PRINT INSTRUCTOR

THIS volume, by a noted finger print expert who was for many years in the Bureau of Criminal Investigation of the New York Police Department, instructs in every phase of finger print work from the taking of the finger impression to the final job of identification. Classification of prints, filing of records, use of equipment, discovering and recording for study the prints left at the scene of a crime by criminals in fact, every procedure in the whole study of the science is clearly and fully explained and well illustrated with numerous cuts of prints. To the text that has long been standard there have been made many revisions and the full story of the development of the science added so that the user may qualify as an expert in a court of law despite efforts of opposing lawyers to trip him up. New illustrations as well as a lengthy new section on the "Modification and Extension of the Henry System" as used by the United States Bureau of Investigation have also been added.

By
Frederick Kuhne

Revised and Enlarged

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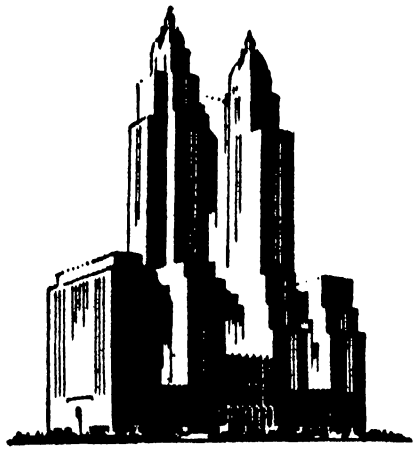

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finally developed. It consists of the use of small doses of high voltage X rays delivered through several small portals cross-firing on the tumor. The treatment must be continued over several months and sometimes even for a year or more. The tumor slowly regresses, leaving a small scar, encrusted with lime salts, which does not interfere with vision.

Bicycle Generator

BICYCLES have staged a come-back, so it is natural that a new generator should have been designed to supply a suitable source of electricity for bicycle lights. The unit is attached to the frame, under the seat, and a friction disk lightly

Electric generator for bicycles

engages the rear wheel. The generator does not interfere with the rider in any way and may quickly be turned into the "off" position when not needed. Sufficient current is generated at eight miles per hour to light brilliantly both the head light and tail light. It is always ready and there is no need of worry about the lights when they are needed most, which is not always true when batteries are used. The generator is easily and quickly installed on any bicycle.

Colds, 'Flu and Pneumonia

THE road now seems cleared for the conquest of the common cold, influenza, pneumonia, and other diseases of the nose, throat, and breathing organs. The achievements of medical science which have cleared such a "possible" road are reported by Dr. A. Raymond Dochez, professor of medicine in Columbia University School of Medicine, according to *Science Service*.

The common cold and influenza occupy "the key positions in the whole pattern" of infection of the breathing tract, Dr. Dochez has concluded as a result of studies by himself and other medical scientists. These two diseases are caused by agents known as filterable viruses.

If an effective means of vaccinating against these two diseases could be developed, it would mean not only control of the colds and influenza but also a possible lessening in the amount of all serious bacterial infections of the breathing organs, Dr. Dochez gave as his opinion.

Asserting that the goal of his studies on respiratory disease and a possible road to it have become clear, Dr. Dochez described the following achievements which helped to clear the way:

1. Studies showing that the common cold is caused by a filterable virus.

2. Growth in the test tube of large amounts of the cold virus, which has been kept alive outside the body for 20 months.

3. Growth of the virus of influenza in the test tube.

4. Transfer of the influenza virus from man to the ferret and from the ferret to the white mouse.

5. Discovery that the influenza virus from different parts of the world and obtained at different periods of time is very similar in its activity.

SPEED

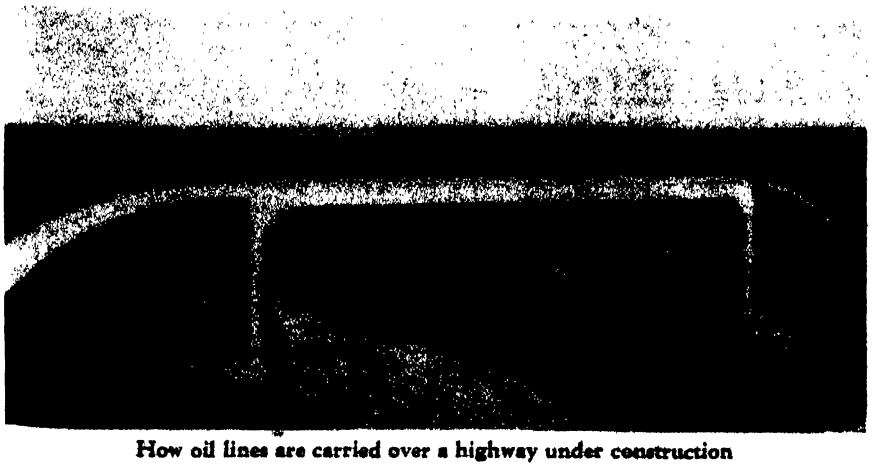
MAN can out-spin the silkworm but man does this fast spinning in glass. The silkworm requires several weeks to spin 6000 feet of silken fiber but the glass manufacturer can draw molten glass into a smaller and stronger fiber and can equal the silkworm's yardage in three seconds.

Explosion Menace

WARNING of a new explosion menace was recently given by the famous Johns Hopkins University physicist, Dr. R. W. Wood, before the meeting of the American Association for the Advancement of Science. The detonator caps used to set off dynamite blasts are causing damaged fingers and blinded eyes and occasional deaths when they are found in quarries by children or lost in coal during mining. Dr. Wood recently investigated the mysterious death of a Baltimore woman which occurred while she was stoking the furnace. A cap left in the coal had exploded and a small pellet of copper no bigger than the head of a pin was blasted through her breastbone, severed a large artery, and caused death. Experiments by Dr. Wood showed that the minute projectiles are driven by the explosion through even the thickness of two telephone directories.—*Science Service.*

Oil Lines Bridge Highway

THE three 8-inch and three 12-inch pipe lines shown in one of our photographs, carrying gasoline and oil (in the raw), rise out of Kansas plains to give a future highway's traffic the right of way as it dips under a railroad. Carrying the lines over, instead of under, the highway saved considerable work and avoided a low point in the line. These sleek-lined, arc-welded, petroleum carriers, built by Sinclair Pipe Line Company, will remind passing motorists that this is an era of good looks and efficiency for more than cars, trains, and ships.



How oil lines are carried over a highway under construction

Prevents Plant Growth on Masonry

ACCORDING to a Swiss inventor, H. Zimmerli, the growth of plants on walls of masonry can be controlled by adding to the mortar—for example, in the case of water reservoirs, beach walls and the like—substances that prevent the germination and growth of plants. In particular, good results are obtained with the addition of three parts of sodium chlorate and two parts of iron sulfate to 100 parts of quartz sand mortar. It is especially recommended that some sodium fluoride or colloidal silver also be added. Finally, the hardened plaster is sprayed with a dilute emulsion consisting of boiled linseed oil, wool grease, ground fluorspar, ammonia, and 2-percent copper sulfate. This treatment is claimed to be very effective. *A. E. B.*

New Dust Replaces Arsenic

SEARCH for a non-poisonous insecticide that might be substituted for arsenic and that, at the same time, would give effective control of insect pests of vegetables, has been rewarded by the discovery of derris, a tropical plant from which a dust possessing marked insecticidal properties can be produced. Entomologists at the State Experiment Station at Geneva, New York, have tried out this new material against worms on cauliflower and against the Mexican bean beetle with a high degree of success.

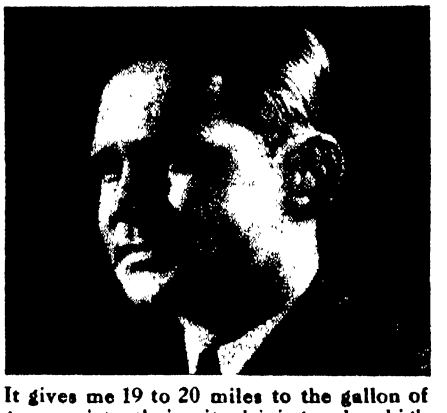
"Although derris is commonly referred to as a new insecticide, it is well to remember that centuries ago natives of Borneo and the Malay States used this plant as a source of poison for fish and for their arrow heads," says a statement from the Experiment Station on this subject. "The fact that it is non-poisonous to man when taken through the mouth has recently given impetus to its development as an insecticide. The dust is made from the ground roots, and it is generally agreed that the chief active ingredient is a substance known as rotenone. A good grade of powdered derris root will contain 4 or 5 percent of rotenone."

In tests carried on by Station specialists, ground derris root diluted with talc so as to give a dust containing 0.5 percent of rotenone has given effective control of caterpillars on cauliflower and of the Mexican

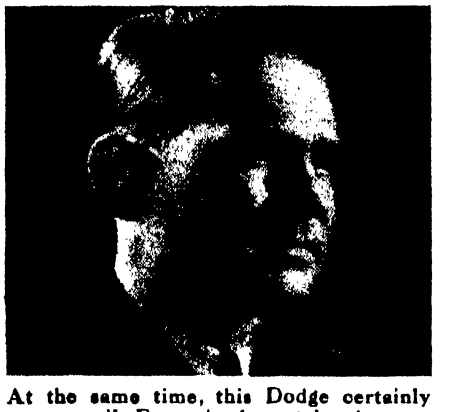
Famous G-Man Corners Dodge Economy

By MELVIN PURVIS, Former Ace of Federal Bureau of Investigation, U. S. Dept. of Justice

One of the most surprising discoveries I've made is the way my new 1936 Dodge saves money!



It gives me 19 to 20 miles to the gallon of gas consistently in city driving and as high as 22 miles out in the country.



At the same time, this Dodge certainly saves on oil. Excepting for regular changes, I've had to add no oil at all.

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bean beetle. The method and frequency of application should follow much the same program as that employed in the use of arsenical dusts.

"In general, it will probably be more satisfactory to purchase the material ready mixed unless the grower has good facilities for mixing dusts," concludes the statement from the Experiment Station. "Owing to the fact that derris deteriorates rapidly on exposure to air and light, the container must be kept tightly closed between applications. Dusting should be at the rate of 25 or 30 pounds per acre, and the material can be applied with a power duster or with a good rotary hand duster. In gardens or small plantings, the dust may be placed in a cheesecloth sack and sifted over the plants."

3300 Gynandromorph Ants

SEX mixups of a most fantastic kind, involving at least one fourth of the population of a large colony of ants, were described by the noted American entomologist, Prof. William Morton Wheeler of Harvard University, in an address before a recent meeting of the British Association for the Advancement of Science. The colony was discovered on the British-owned island of Trinidad last spring, by Dr. N. A. Weber, and was studied jointly by Dr. Wheeler and himself.

The mixed-up condition consists in each affected insect being partly male and partly worker-female or "neuter." In many, the front part of the body looks like that of a male and the back part has a female appearance. In others, "islands" of femaleness appear in the midst of male areas, and vice versa. No two of the insects thus far examined are alike in either the degree or distribution of their assorted sexualities.

In the particular species to which this colony belonged, Dr. Wheeler explained, the males have longer legs than the females. Some of the "sex-assorted" ants had male legs on one side and female legs on the other. The result was that they could travel only in circles, like the famous but fabulous "side-hill gouger" of western American myth.

In all, Dr. Weber has counted some 3300 of these peculiar ants, all of them being offspring of the same queen ant, who was herself apparently normal in every respect. Insects and other animals that display such a patchwork of sex characters are known to science as "gynandromorphs." Taken to pieces, this tough-looking Greek word means "female-male-forms."

—*Science Service*

Accuracy in Hide Finishing

MILADY'S gloves must be delicate, thin, and flexible. Mere man can stand heavier materials, and is not so particular about whether the fit is skin tight or not. But nature does not make animal hides of uniform thickness, and it is necessary for glove manufacturers to "shave" the tanned hides to uniform thickness. This operation consists of passing the hide under a rapidly revolving abrasive roll, which grinds off the surface and reduces the thickness to the desired degree.

Ordinary grinding is one thing, but hide

Preserving Proof of Invention

EVERY inventor who is working on a device which he contemplates patenting should first prepare sketches and a description of his invention, which should be dated and witnessed by at least two persons. The inventor has thus established the date of his disclosure, and such evidence should be deposited in a safe place from which it may be produced when needed.

When an invention has been completed, it is advisable to file an application for patent without delay. However, we realize that many inventors today do not have sufficient funds to meet this expense, nor have they safe places in which to keep their disclosures. Therefore Scientific American will undertake to act as a depository for such documents without charge. These will be held in safe-keeping for two years (unless withdrawn by the depositors) and then destroyed without opening.

To take advantage of this offer, place your papers in a sealed envelope endorsed with your name and address and marked "Not to be opened." Then enclose this in another envelope addressed to A. P. Peck, Associate Editor, Scientific American, 24 West 40th St., New York, N. Y., and mail.

—*The Editor.*

finishing is another, and extreme accuracy is required. The least wobble in the roll would ruin a hide. This might not seem to be such a problem until one realizes the size of a hide. The Curtin-Herbert Company, however, makes a machine that meets these requirements without any difficulty.

The machine which does this work has a roll 50 inches long, directly connected to a five horsepower motor. This roll is covered with fine emery dust or extra fine sandpaper and turns at 1155 revolutions per minute. To insure freedom from friction and to guarantee accuracy of adjustment, the grinding roll is mounted at both ends on Timken tapered roller bearings.

The adjustment of the grinding roll is so delicate that a piece of newspaper or a magazine page may be passed under the roll and only the surface ink will be removed, without cutting through or tearing the paper. This means that only about a thousandth part of an inch, less than the thickness of a human hair, may be removed.

With equipment capable of such accuracy over a 50-inch span, many hides that would otherwise be made up into men's gloves or shoes can be worked to the delicate thickness required by women in their fancy gloves. Surface blemishes and flaws in the face of the hides can be eliminated without injuring the body of the hide. Absolute uniformity without even a thousandth of an inch of wastage in thickness can be main-

(*Please turn to page* 224)

There are Times When This New Book becomes the Book of Books

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Convalescent Days
Holidays at Home
Neighborhood Parties
Winter Sports
Special Holiday Programs
Quiet Games for Warm Weather
Puppet Shows and Backyard Circus
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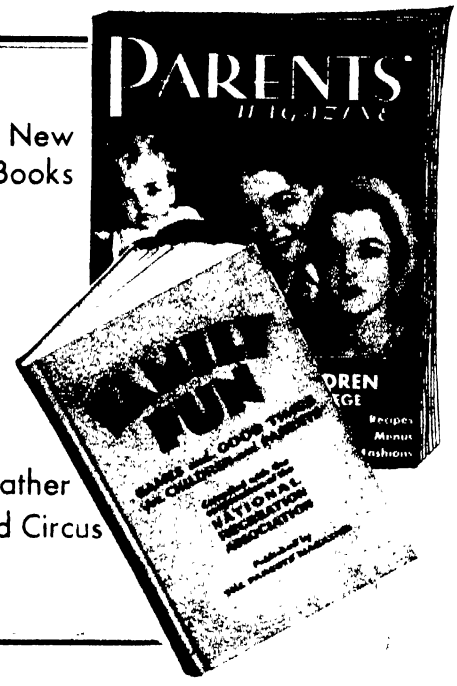

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THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

THE matter presented below, regarding the McMath-Hulbert Observatory, is a continuation of the short article on page 176, the intention having been to segregate there the less technical parts of the account, and to reserve the remainder for this department; thus not offering it to those of the general readers of the magazine who are not telescope enthusiasts such as the readers of this monthly department are. The following added data were furnished by Robert R. McMath, the director of the observatory, at our request.

Spectroheliokinematograph and 10½"

"Reference to the picture [page 176.—*Ed.*] will show the dome which houses the 10½" Pyrex reflector, in the lower right hand part of the picture. This instrument is carried by a Bruce type mounting and is used with many different combinations. Quartz secondaries provide for focal lengths of 200", 540" and 850". A 6", *f*/6.5 Petzval lens, which is often mounted on the side, provides speed and wide angle.

"Early in 1932 work was started on an instrument which we christened the 'spectroheliokinematograph'. Essentially this instrument is a spectroheliograph plus a motion picture camera and such an instrument makes it possible to photograph solar phenomena in the light of some chosen wave-length or element alone. The addition of the motion picture camera has made it possible, for the first time, to secure continuous records of solar phenomena. The spectroheliograph has for its optical train a Littrow type spectroscope employing a 4" Ross collimating lens of 72" focal length. This lens was designed by Prof. Ross and made especially for this instrument. A 4" grating, 20,000 lines to the inch, is in service at this time and the spectroscope, plus the camera, is mounted on the 10½" equatorial telescope. Those who are interested in detailed descriptions are referred to the various publications of the University of Michigan Observatory" [usually available for consultation at the different professional observatories, but otherwise difficult, at this date, to obtain.—*Ed.*]

In describing the new solar tower, McMath writes: "If the reader will refer to the accompanying line diagram, it will perhaps be easier to follow this description. Experience has taught us that there is no substitute for mass in designing a photographic telescope. Consequently, all parts of this instrument are very heavy. As an illustration, the combined coelostat and flat mountings will weigh a little over six tons.

"Our dome on the solar tower is 17′ in diameter inside, and the effective shutter opening is 4′. We used a standard water tank bottom for this dome and cut the shutter opening out with a torch. The base ring is an 8" x 6" x ½" angle and the weight is carried on eight rollers, spaced at 45°. An additional eight spacing rollers keep the dome concentric. Construction is entirely of welded steel.

"The outside shell is 17′ in diameter and the inside tower is 6′ in diameter. Each tower is supported on its own columns and the foundations for each set are separated. Optical tests made show that no vibration is transmitted from the outer shell to the inner tower, which carries the coelostat. The workroom is 28′ in diameter inside the octagon, giving ample space in which to work.

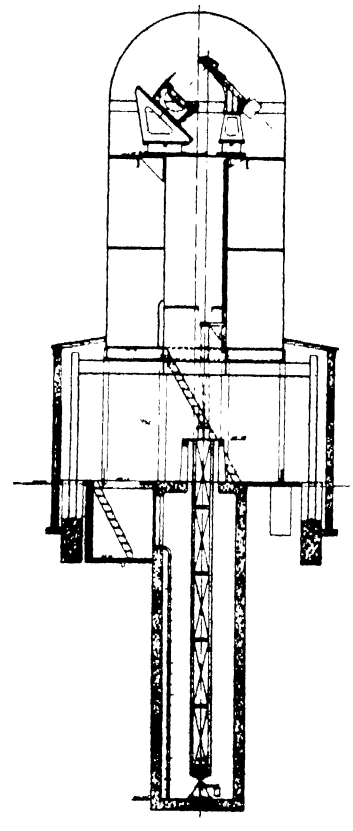
"Entrance to the spectroscope pit is through an underground photographic darkroom, which will be provided with water and necessary equipment. The pit is 7′ in diameter and 30′ deep. It has an inner steel lining which was welded water-tight. This pit houses the spectroscope and is provided with a steel cage 2′ square, of which about two thirds is carried on the bottom bearing and the remaining one third on the upper ball bearing in the pedestal. The pedestal, at ground level, is 4′ high and the actual, net working surface of the rotatable pedestal top is a circle whose diameter is 52".

"The coelostat mirrors are of optical Pyrex. The first mirror is 22" in diameter and 5¼" thick. The flat is 18" in diameter and also 5¼" thick. Sunlight passes through the shutter to the coelostat mirror, thence to the flat mirror, and then straight down the inner tower to a 12" parabolic mirror of 20′ *e.f.l.*, at the pedestal. This mirror is figured off-axis, and returns the now converging beam back up the inner tower to a 9½" Pyrex flat [Note bracket.—*Ed.*] This flat reflects the converging beam to its focal point on slit No. 1 of the spectroheliograph. Provision has been made at this point for the use of a 16", 40′ *e.f.l.* mirror to give a larger image of the sun.

"Light from the first slit of the spectroheliograph travels down the pit inside of the cage to the collimating lens. We expect to use either a 15′ or a 30′ spectroscope, as the need may arise. This diverging beam passes through a 6" clear aperture collimating lens and falls upon a 6", 15,000 line plane grating. Light of the desired portion of the spectrum is returned by the collimating lens to the second slit of the spectroheliograph. The camera is, of course, focused on the second slit. These slits are arranged to move in opposite directions at exactly equal speeds and the resulting picture is a spectroheliogram taken with light of one wavelength.

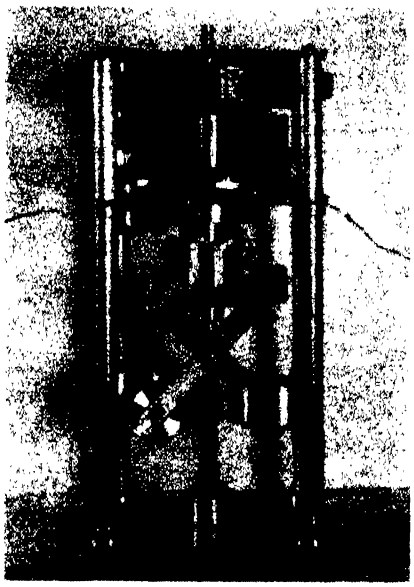
"The coelostat and motion picture camera will be driven by the present equipment located underground, to the northeast of the 10½" dome. All other slow motions, driving rate controls, chronographic recording, mechanism for controlling ratio of light to dark time on the motion picture film, and so on, that have been found essential in our previous work, are also electrically controlled in the new tower by merely extending the electrical circuits from this underground control room. Our method of driving and controlling equatorial telescopes has been described in the *Publications of the University of Michigan Observatory*. Space prevents a detailed description at this time, but it may be said that the reason for building a solar tower at this location is because of the fact that the existing equipment can be used in toto.

"Some years ago the entire observatory was given to the University of Michigan and is now operated as a branch of the University of Michigan Observatory. It has been financed entirely by private gifts. If a satisfactory example of an amateur is an individual who fails to make money following a hobby, then the present director and staff are amateurs de luxe.



Elevation of the solar tower

"All of our equipment is 'home-made,' and has been built from designs made largely by the present director. The mountings and so on have been made by the Motors Metal Manufacturing Company of Detroit, the steel work and so on by Whitehead and Kales Company of Detroit and, with the exception of the two large mirrors for the coelostat, the optical parts are from J. W. Fecker, of Pittsburgh, Pa. The two



A close-up photograph of a clock drive made by E. H. Morse, of Altadena, Calif. It drives the 15" reflector shown on p. 355, "A.T.M."

coelostat mirrors are being figured by the Warner and Swasey Company of Cleveland, Ohio."

The spectroheliokinematograph described above by McMath and shown on the opposite page consists of a metal box weighing 70 pounds containing a modified (shortened focal length) Hale spectroheliograph and a 35 mm. motion picture camera. Anderson prisms are used, and are driven by a small air turbine. A day's photography of the sun consists of about 600 separate spectroheliograms, and these give a motion picture when run off rapidly. With the solar tower equipment as many as 720 exposures per hour will be obtained.

THE following is a suggestion made by J. R. Haviland, 426 Second Ave., Lyndhurst, N. J., under the heading "Things to Try." Perhaps someone will try it out. "A German patent formula for preventing tarnish on silver (used on silverware) might be tried out on silver films. Solution of potassium chromate in water. Immerse silver at room temperature 5 to 10 minutes. The very thin layer of silver chromate formed is transparent and protects the film. May not work on a mirror."

SOMEWHAT belatedly we have run across an article on "nervous breakdowns," in the April, 1935, number of *Fortune*. This states that telescope making is being used as "occupational therapy" at a mental sanitarium in the mid-West. Whether it will help the patients or drive them quite crazy is something of a question. Perhaps the wives of those who read this department and follow the hobby will throw pertinent light on this matter.

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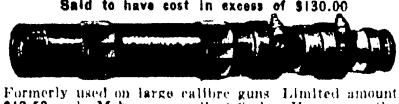

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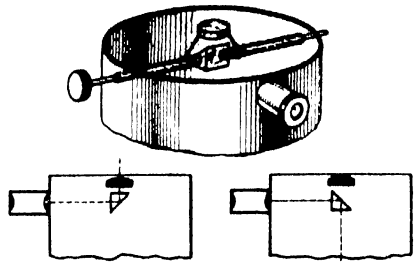
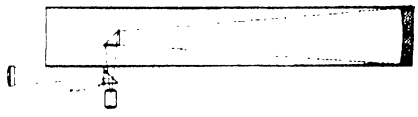


Wyld's prism-finder combination



Parks' finder-prism combination

THE dingbats shown above are combinations for using finders without added inconvenience. The one at the top was suggested by James Hart Wyld, 307 Foulke Hall, Princeton, N. J. The regular prism carries a finder objective on a bipod or bracket, and is rotatable against stops. The lower one is by M. C. Parks, Electric Vacuum Cleaner Co., Cleveland, Ohio, and, like the first, explains itself. In both cases the prisms rotate.

HERE are some solid data from Horace H. Selby, a chemist, of San Diego. "Since last you wrote," he says, "I've attempted to compare the Foucault test with the Ronchi, on several surfaces, both directly and with a flat. Briefly, my conclusions are:

"*1:* The two methods are equal in sensitivity at *f*/6 direct, and at *f*/12 with a flat.

"*2:* Ronchi is better at large aperture ratios: *f*/1, *f*/2.3, *f*/4.5.

"*3:* Foucault is better at small ratios: *f* 6.8, *f*/8, *f*/10.

"*4:* Neither is sensitive enough (±0.1 wave) below *f*/4.5.

"*5:* Straight-edge, diffraction (Everest test) and Ronchi are equal for edge.

"*6:* When using a flat or a Hindle sphere, these surfaces must be pretty near to fairly good: ±0.1 wave is none too close.

"All of the above was done with 120-line-per-inch Lower wire grating and smoked razor blade. In all comparisons, source (pinhole) and eye were precisely together on the axis. Surfaces used had apertures of 1.09, 1.4, 2.3, 3.5, 4.5, 6, 8, 10 and 11.3. Sensitivity was judged by polishing grooves in surfaces with pitch laps ⅛" diameter, loaded 50 grams per square centimeter, and using black rouge washed from old, worn-down stock.

"Don't forget," Selby adds, "that others may not get the same results."

Comments on the above: Everest—"I choose the old tin can and razor blade." Sheib—"Interesting. I agree with Selby on No. 3, also No. 4 and No. 5. I am not sure I agree with him on No. 1 or No. 2."

Well, there it is—now it is a public fight, along with who is going to be the next president. Great pains should be taken to eliminate variables, in making tests similar to these.

HERE are some further data from Selby who is the one who made the "dinosaur" telescope described last July, also a whole fleet of flats.

"Regarding the cutting speeds of polishing materials," he says, "I find:

"With very hard pitch, No. 600 pits, load 50 grams per sq. cm., stroke 250" per min:

Rouge	Black Arg. Glass	Plate	Pyrex
B. and L.	9 hrs.	8 hrs.	10 hrs.
Am. Opt. Co.	5½ hrs.*	6 hrs.	5 hrs.
H. W. and M.	8 hrs.	7½ hrs.	10 hrs.
Clark	10½ hrs.*	9 hrs.	
Black "rouge"	12 hrs.	11½ hrs.	14 hrs.

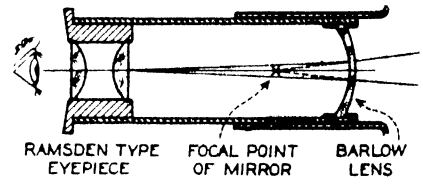
"*Remarks:* Black glass is softest, Pyrex hardest. Surfaces made with B. and L., H. W. and M., and Clark, equally good; Am. Opt. Co., worst; black, best. All trials were duplicates, except those starred, which were singles. Pyrex shows more shallow pits, grade for grade, than the others. These results are not precise, but they are comparable; for example, fine grinding was uniform in all cases—same stroke, speed, same loading, same percentage of Carbo. in suspension.

"Very hard laps of pure pitch polish much slower than pure pitch laps of medium hardness on Pyrex.

"Regarding tendency to scratch, with superhard laps on Pyrex, B. and L. sleeks and scratches least, Clark next, then Fuller's black, then Am. Opt. Co., and worst, H. W. and M.; although, with a medium lap, none scratches at all."

Naturally, this is only one man's findings. He does not claim they are final.

In Selby's notes, "Black Arg. Glass" refers to a special melt called "Marbletex," from Wells Glass Co., Kokomo, Ind. "H. W. and M." refers to Hanson, van Winkle and Munning Co., East Matawan, N. J. "Clark" refers to Alvan Clark and Sons Co., W. Somerville, Mass. The other two are mentioned in "A. T. M." The black "rouge" was from W. P. Fuller Co., San Diego, Calif. Binney and Smith, 41 East 42 St., New York, make black rouge but your scribe has not yet tested it. Some black "rouge" which H. A. Lower sent him proved to be as scratchless as a newly hatched chick. It is slow (note Selby's figures), but after no end of trouble with scratches Lower found it a haven of rest.



Hiner's Barlow eyepiece layout

THE cut above shows how W. B. Hiner, 123 Cleaves Ave., San Jose, Calif., added a Barlow lens to an eyepiece. In this case it was one component of an old camera lens, a meniscus. The Barlow principle is explained by Hindle, in "A. T. M.," p. 215. If the lens is arranged to slide along the axis, as explained in "Splendour of the Heavens," p. 751, the amount of magnification may be varied at will.

A NEW aluminum evaporating outfit installed by Leroy M. E. Clausing of Chicago is shown opposite. He writes: "The enclosed print is one that I made of the evaporating outfit. The streaks of superbrilliancy on the 20" flat are not caused by super-reflection, but are due to my moving the light to the wrong place while taking the picture.

Clausing's new evaporating rig

"Starting at the floor, you first see the 2 H.P. motor that drives the 'Hyvac 100' pump, which is right back of it and is only partly visible. It gives a final vacuum of 3×10^{-5} mm. of mercury. Above this is the heavy reinforced steel plate upon which the steel 'jar' rests. The steel jar with its ports may look like a Buck Rogers contraption, but the extensions are merely to keep the aluminum vapor from reaching the glass ports. There is approximately 18,000 lbs. pressure on this jar when exhausted, but it stands up O.K. In the rear you will see a small steel jar which I use for small mirrors and special work."

Perhaps others who do evaporating will send in similar pictures.

THE following communication, entitled "Science and Facts," has been received:

"So-called modern science teaches that the earth revolves or rotates on an imaginary axis every 24 hours; and that the sun is stationary; and that the earth whirls around the sun once a year. It also claims that the sun is a larger body than the earth, and that the sun is 93,000,000 miles from the earth.

"It can be proved by more than 100 different facts that this is all nonsense and imagination.

"In the first place, the earth is too large and too heavy a body to be able to rotate or to revolve. Such a movement would also be perpetual motion.

"It would also be impossible for the earth to rotate or to revolve evenly and regularly, on an axis, every 24 hours, as the axis would sooner or later wear away, thereby causing the earth's poles to become lopsided, which would then cause the earth to rotate or to revolve unevenly and irregularly.

"It would also be impossible for us to live more than a few minutes, with the earth traveling at such a speed as 1000 miles an hour, as we would all soon suffocate. And it would also be impossible for the clouds, traveling at the rate of 40 miles an hour, to catch up with the earth. It would also be impossible for the sun to heat and warm the earth, with the earth traveling at the rate of 1000 miles an hour, as the earth would soon freeze up solid in a few days."—W. J. BARTH, *Howard Lake, Minnesota, Authority on Science.*

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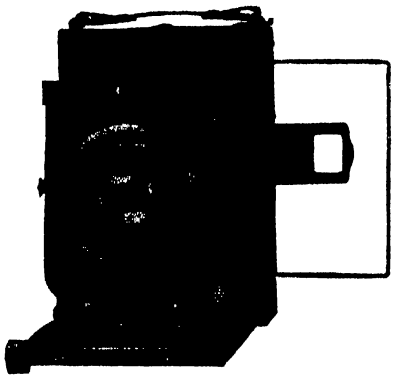

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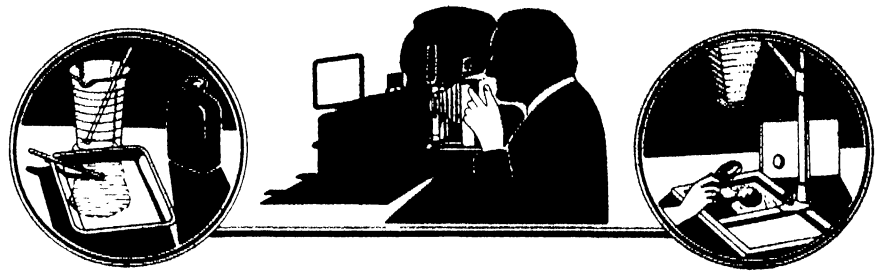

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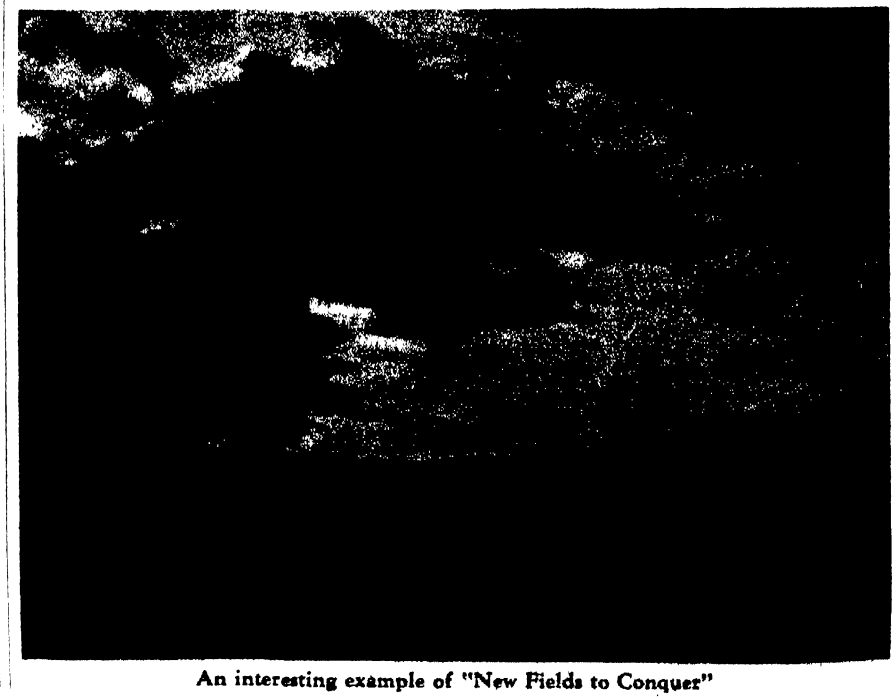
New Fields to Conquer

A FACTORY smokestack used to be regarded by the camera hobby fraternity as a disgrace to the landscape; today it is often the other way about. Many workers prefer it. An explanation may be that economics, once a dull subject about which dull academicians wrote dull treatises, is today a living issue discussed with zeal, varying degrees of knowledge, and more or less intelligence in the "best" circles as in the humblest. With heads out of the clouds and feet squared firmly on Mother Earth, we survey life's realities and fear them not. We photograph them. We see beauty in smokestacks and in factory interiors, in gears and motors, girders and concrete mixers, the varying phenomena of construction in a world that, for better or worse, moves ever forward in material expansion and growth, and, in this very movement, as well as in its static moods, presents the photographer with widely varying material. All he needs is an eye that "sees"—in the photographic sense.

The gleam of machinery, the blinding brilliance of rushing metal, the grace of a swinging crane—these are but aspects of the new, realistic approach. The scientific laboratory, with its test tubes and retorts, the waterfront at cargo loading time, men at work on bridge tower and skyscraper, "holing" through a new tunnel, shaping hot metal—these and many other subjects are now the happy hunting grounds of the pictorially minded.

Recently a newspaper queried the photographic agencies for a "dramatic" picture showing a freight car being loaded. Formerly such a request would have seemed ludicrous; today it is assumed that it will be filled without question and not only dramatically but beautifully as well. Extensive use is being made in this type of picture of filters which give a dark sky. A deep yellow filter, more preferably a light red or orange-red, is indispensable in such work; by darkening the sky, industrial scenes that include a good portion of the sky are brought into striking prominence and relief, making all the difference between the ordinary and the unusual. A medium yellow filter during the day, or no filter at all in late afternoon when the sunlight tends to yellow, will render clouds in approximately the relation that we see them with the naked eye. Such pictures have a definite atmosphere about them that is so desirable in depicting certain moods. Shadow patterns cast on a factory wall frequently offer interesting material. Good composition is important, and especial care must be taken in this regard when pointing the camera at an angle to get a "worm's-eye" view. Just placing the camera at an unusual angle is not all there is to "angle photography." See this Department, October, 1935, for hints on this subject.

Study the work of the best industrial and



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2. Entries will be judged on the basis of pictorial value and photographic technique. The decision of the Judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.
3. All of the photographic work involved in producing prints for this contest must be done by the contestant.
4. Photographs submitted must be printed in black and white on glossy paper and must be mounted.
5. Prints must not be under 7 inches or over 14 inches in their longest dimension. Mounts must not be larger than 14 by 17 inches.
6. Photographs must be submitted by first class mail, with sufficient cardboard included in the package to protect the print.
7. Each entry must have the following information written on the back of the mount:

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   If indoor, contrast of paper used;
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10. Non-winning entries will be returned only if postage is included when the prints are submitted.
11. No entries will be considered from professional or commercial photographers.
12. All entries in this contest must be in the hands of the Judges by June 20, 1936. The results will be announced in our issue dated September, 1936.
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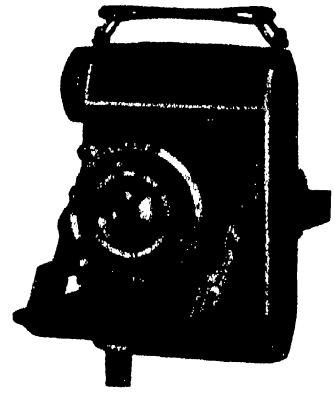

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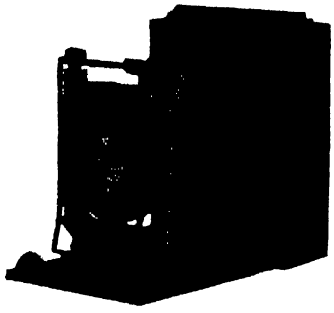

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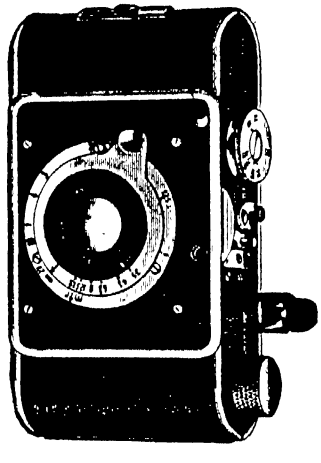

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"QUINOLIN"

UNDER the name "Quinolin" a new prepared developer is made available to the camera worker who prefers to have his chemicals ready mixed so that all he has to do is add the necessary amount of water for dilution to working strength and in order to give volume. According to the manufacturers, this developer, employing a developing agent never before included in a prepared developer, "brings out the entire tonal range from deepest blacks to strongest highlights." It is said to last longer than the usual type of metol-hydroquinone formula and to give, by direct development and the use of chlorobromide papers, warm black and black-brown tones. Used with chloride and bromide papers, pure black and blue-black tones are said to be obtained. The developer may also be used for negatives.

NEW LENS SCREEN ELIMINATES GLARE

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The new screen would seem to be the perfect answer to the photographer who has been troubled time and again by the oblique glare coming from certain polished surfaces and bothersome reflections that do not belong in the picture. In addition, the new device when used in "shooting" against a blue sky provides a dark sky; also, the Pola-screen helps to control the relative brightnesses of walls and roof in architectural pictures.

The distributors announce that the new device "is a practical application of the fact

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that light rays normally vibrate in all directions at right angles to the ray itself but under some conditions become 'polarized,' meaning that all directions of vibration but one have stopped. This occurs in oblique reflection, and in the light coming from a clear blue sky."

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GHOSTS are usually associated with things past. In the illustration below, based on our cover for the December issue, we present a ghost of things to come. Once

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What specific phases of advanced amateur photography do you want to see treated in this department? These columns are yours and you can help to make them better. Drop us a line and we will do our best to co-operate.—The Ed.

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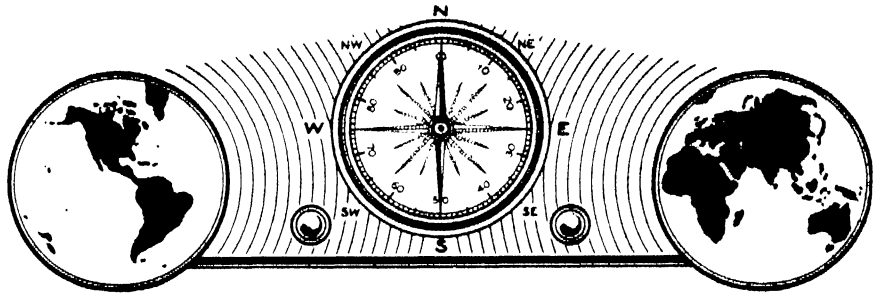


WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

Radio Noise Silencer

NATURAL static and man-made noise are the greatest drawbacks to radio communication. Millions of dollars have been spent in attempts to reduce these forms of interference to negligible quantities. This has been accomplished to a degree in broadcasting by using transmitters of such high power that the signals can over-ride the noise. In commercial communication the condition has been relieved somewhat by the use of directional antennas, controlled-angle radiation, volume compression, and by placing the receiving stations in locations free from man-made noise.

Little progress was made in attempts to eliminate the noise in the receiver. There appeared to be no solution to the problem.

A partial solution has now been advanced, and the system seems practical enough to warrant further investigation. It has the drawback of not being capable of eliminating all types of interference. Moreover, by reason of the nature of its functioning, it is apt to destroy the quality of a musical program spotted with certain types of noise interference. But the system will accomplish a great deal, nevertheless, and will find ready application to short-wave receivers wherein noise is particularly objectionable.

The device is the invention of James J. Lamb, Technical Editor of *QST* magazine. It employs two tubes which amplify and rectify the noise impulses to the exclusion of the signal. The voltages developed by the noise impulses are then used to silence the radio receiver.

The functioning of the device is based on the fact that average noise impulses, such as those created by an automobile ignition system, are widely separated and of short time duration. The ear is insensible to impulses so widely spaced and of such short duration, but through the processes of amplification in the receiver and reproduction of the sound from the loudspeaker, such impulses have their duration increased from around one thousandth of a second to as much as one hundredth of a second. Impulses having such duration are audible.

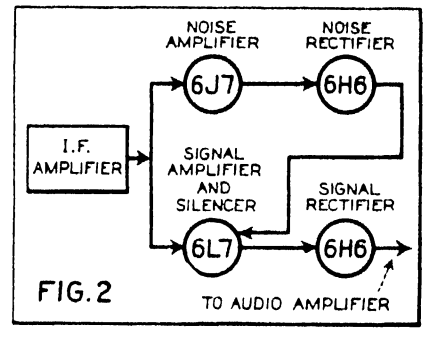


FIG. 2

The trick, then, is to catch the noise impulses before their duration is increased appreciably, and to use the voltages set up by these impulses to *punch holes of silence* in the received signal at the exact time-spaces where the noise impulses appear. That is, to wipe out both the noise impulses *and the signal* at these time-spaces. Just so long as the spaces of silence have the same short durations of the noise impulses they replace, the ear will be insensible to the interruptions and will hear the signal as a continuous sound.

The sketches of Figure 1 will serve to indicate what transpires. Sketch A shows the continuous signal which is maintained at a constant level by the automatic volume control in the receiver. The noise silencer is adjusted so that it will go into operation on any impulse having an amplitude greater than the signal level. There is shown superimposed on this signal a group of noise impulses, some of which have amplitudes less than the signal and some of which have amplitudes greater than the signal. Since it is necessary that the operation of the noise silencer shall not in any way affect the continuous signal, it is evident that it cannot cope with the noise impulses the peaks of which are below the signal level. However, it will go into operation on any impulse the peak of which is above the signal level and, for the instant the impulse is present, silence the receiver.

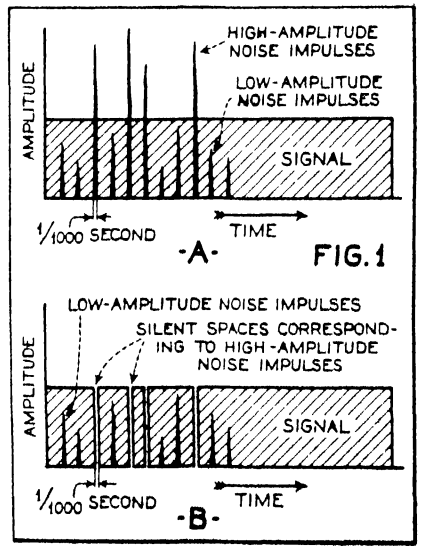


FIG. 1

*Editor *All-Wave Radio*

The result is shown in sketch B of Figure 1. It is seen that the small noise impulses are still present, but they are not particularly objectionable as the signal is able to override them. Note, however, that the strong noise impulses have been wiped out, and in their place are holes of silence.

The noise silencer is really nothing more than a quick-action automatic volume control system. It is shown in block diagram form in Figure 2, and is seen to consist of a 6J7 tube which amplifies the noise impulses and a 6H6 tube which rectifies the noise impulses and converts them into direct-current impulses, the voltages of which are negative in value. These two tubes are adjusted so that they do not function on the constant signal voltage.

Below these tubes are shown the 6L7 intermediate-frequency amplifier tube in the receiver and next to it the 6H6 second detector and automatic-volume control tube. Just as long as the signal is not accompanied by noise impulses greater in amplitude than that of the constant signal level, the signal passes through the 6L7 and 6H6 tubes where it is amplified and rectified in the usual manner. However, if a noise impulse appears, it sets the noise silencer into action. The impulse is first amplified by the 6J7 tube and then rectified in the circuit of the 6H6 tube. The resulting instantaneous negative voltage appearing in the output circuit of the 6H6 tube is fed to the Number 3 grid of the 6L7 intermediate-frequency amplifier tube in the receiver. The effect of this negative voltage is to bias the 6L7 tube to cut-off, at which point it no longer functions as an amplifier. At that instant, then, the receiver is silenced. As soon as the original noise impulse ceases, the negative voltage in the output of the 6H6 noise rectifier tube disappears and as a result the 6L7 tube is returned to its original condition of maximum amplification.

Thus, for every large noise impulse, a "bullet" of negative voltage is fired on to the Number 3 grid of the 6L7 tube and the receiver is silenced. At all other times the receiver functions in its normal manner.

Volume Expansion

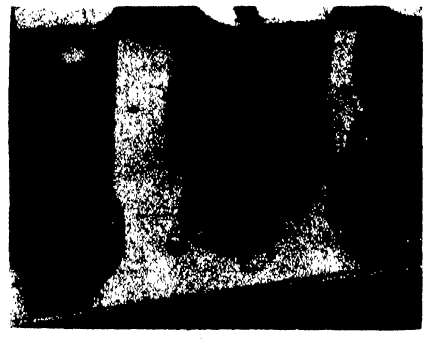
MUCH of the naturalness of reproduced radio orchestral music is lost if the original volume range is restricted or compressed. The feeling of musical depth is lost, and the proper relation of fundamental frequencies and overtones is not obtained if the volume peaks of the original rendition are appreciably reduced.

A symphony orchestra will have a volume range in the neighborhood of 70 decibels when playing, say, certain portions of Rimsky-Korsakow's "Scheherezade." That is, the range of sound volume, from the softest to the loudest passage, will be 70 decibels.

It has not been possible to reproduce by phonograph or over the radio any such volume range. A phonograph record has a volume range no greater than 45 decibels, and possibly as much as 5 decibels of this range are made unusable by needle scratch. The average broadcast transmitter has a volume range of only 40 decibels. Any attempt to increase this range either places the soft musical passages below the noise level at the receiver, or places the loud passages beyond the safe limits of carrier modulation.

But means have been devised for opening up a compressed volume range at the point of reproduction. The RCA Manufacturing Company have incorporated a "volume expander" in a new radio-phonograph combination. The expander is not used with the radio, but produces a volume range of 65 decibels on recorded music.

This is accomplished by using a variable-gain audio-frequency amplifier in such a manner that the greater the volume of the music, the greater the amplification. The result is that soft musical passages retain about the same relative volume level they have on the record, but the louder passages



A radio volume expander

are considerably increased in volume level. Thus, a musical passage having a volume-level value on the record of 40 decibels is expanded so that the actual relative volume-level at the loudspeaker is slightly in excess of 60 decibels. Thus, the 20 decibels or so lost in a recording of the original orchestration are put back by the volume expander.

Volume expansion has also been added to the radio receiver. The Crosley Radio Corporation have developed a device called the Auto-Expressionator which is being used in a few of their latest receiver models.

The Auto-Expressionator is also a volume expander, but instead of employing a variable-gain amplifier, two small bulbs are used; these bulbs have special filaments, the resistances of which increase with an increase in current flow.

There are two paths through which the audio-frequency currents may flow. The loudspeaker is connected in the circuit of one of these paths, and the Auto-Expressionator bulbs are in the other path. At low volumes the signal divides equally between the two paths, causing the loudspeaker to operate at only half volume. As the volume of the signal increases, the Auto-Expressionator or bulb path becomes more and more restricted, causing more and more audio-frequency current to be diverted and to flow through the loudspeaker, thus resulting in a volume increase greater in proportion than that supplied by the receiver.

The method of operation of the Auto-Expressionator is somewhat similar in principle to that of the Wheatstone bridge. It consists of a division of the current into two paths. The amount of current flowing in each path is dependent upon the amount of resistance present. Since the filaments of the Auto-Expressionator bulbs vary in their resistance values with a change in signal-current flow (volume), the division of current flowing in each path is altered in accordance with changes in signal volume.

The Auto-Expressionator operates continuously during the time it is turned on, even though the bulbs may not be illuminated. The functioning is immediate and automatic.

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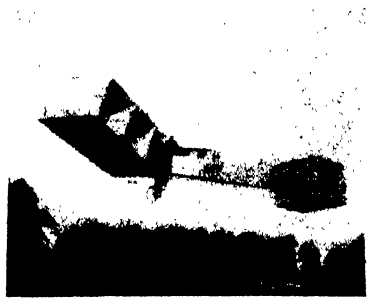

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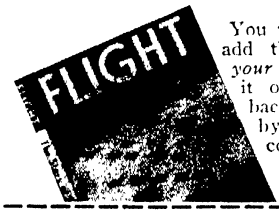

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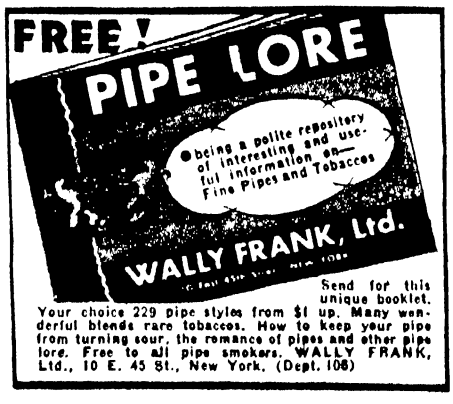

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 213)

tained. Even hides, thick or thin, always work up most satisfactorily.

Precision construction features equipment of this kind. Every part must be finished with microscopic care. The roll must be rigid, and there can be no play in the bearings. Even the least wear in the bearings, which support the roll, would result in spoiled or uneven hides. The Timken bearings used in this machine can be adjusted to the hair-splitting degree of accuracy necessary to insure smooth, friction-free operation at high speed, and to give absolute steadiness and long life under operating conditions."

New "Bar-filament" Auto Bulb

FOR a new type of headlight which is standard on many of the 1936 cars, the Incandescent Lamp Department of the General Electric Company recently developed a new headlight bulb which differs considerably from other headlight bulbs in that

the filaments, instead of being V-shaped and placed one above the other, are in bar form and are located side by side with one slightly above the other.

In switching from the one filament to the other, both headlight beams are simultaneously shifted to the right and are lowered somewhat. This provides illumination of higher intensity along the right hand side of the road and at the same time gives relief to the oncoming driver.

The new bulb is equipped with the now familiar pre-focused base. The contacts, however, are so positioned that they will line up only in headlamps that have been especially designed for the new bulb.

Medicines Will Taste Better

BETTER-TASTING medicines will apparently be one result of changes in the National Formulary, which might be called an official recipe book for pharmacists, says *Science Service*. The changes embodied in the sixth revision of this volume which becomes official on June 1, 1936, are explained by Dr. Adley B. Nichols, secretary of the National Formulary committee on revision.

The National Formulary—known as N.F. for short—is a companion to that other legal standard for drugs in the United States, the U. S. Pharmacopoeia. The latter includes drugs and remedies of proven efficacy, regardless of whether they are widely used or seldom used. Products are included in the N.F., on the other hand, on the basis of how generally they are used.

In the present revision 321 items were dropped from the book because a survey of over a hundred thousand prescriptions, collected from all parts of the country, showed that these items were not used in actual practice. A total of 233 new items were admitted.

Six glandular products were admitted—corpus luteum, ovary, ovarian residue, anterior pituitary, whole pituitary, and suprarenal.

Salty-tasting medicines such as the bromides should taste better because syrup of raspberry is the official "vehicle" for these preparations. The resulting effect is like adding a pinch of salt to bring out the flavor of the syrup.

Syrup of acacia is another new vehicle which makes disagreeable medicines pleasant to take because the colloidal action of the acacia keeps the medicine from coming in contact with the taste buds on the tongue.

Syrup of cherry is another new addition which has been widely acclaimed.

"Its specific value lies in its fruity tartness which makes it a delightful mask for sour products such as the diluted acids, where the acid almost enhances the taste rather than destroys it," Dr. Nichols says.

For a change, pharmacists are advised to use syrup of thyme which has "a markedly different taste."

Tame Cats Gone Wild Down Under

THE cat family, which is carnivorous, had never penetrated Australia until the advent of the white man, less than 150 years ago. That is why Australia's native fauna, which for the most part is herbivorous, has survived from a pre-carnivorous age.

Now, however, thousands of domesticated cats, gone wild, are waging ferocious war on the native bird life of the uninhabited or sparsely populated interior, and, in some districts, wiping it out altogether.

"On a trip of 1600 miles from north Queensland down to Lake Eyre," Ion Idriess, the author, remarked, "I saw countless thousands upon thousands of these cats. Apparently they have been breeding over a score of years, and have grown much larger than the ordinary domestic cat."

Idriess reports that at one water hole he saw 50 cats fighting and tearing one another to pieces while hundreds more snarled down from the trees. Cockatoos and parrots seem to be surviving because they can defend themselves, but other native birds are being decimated.—*Australian Press Bureau.*

Electricity Purifies Milk

PASTEURIZATION has been supplanted by electrical treatment in the plant of Foremost Dairies, Birmingham, Alabama, says *Food Industries*. Passing upward through a vertical box-like vessel with carbon electrodes on opposite sides, the milk is subjected to 215 amperes at 220 volts. The milk itself conducts the electricity from one electrode to the other and the minerals in it offer sufficient resistance

to raise the temperature to 165 degrees. The milk is five seconds in passing between the electrodes and is 15 seconds in the detention period, making a 20-second exposure to the high temperature.

This method is said to give highly accurate control, the milk being delivered by a constant-speed pump through a constant electrical discharge. Another advantage attributed to the process is that the milk does not contact any hot equipment, so that there is no oxidation or deposit of milkstone on the utensils. Furthermore, it is said, the method does not alter the flavor, caramelize the sugar, change the color, or break down any elements of the milk.

The equipment handles 600 gallons an hour at a cost of approximately 45 cents per hour for electricity. *A. E. B.*

RAILROAD SAFETY

TRAINS on the 800 railroads of the United States, operating over a total of 420,000 miles of track in 1935, carried human beings an aggregate of 18,400,000,000 miles without a single passenger losing his life through a passenger train accident.

Chickens Take Submarine Rides to Aid Science

A "CHICKEN-SUBMARINE" is Cornell University's latest contribution as a tool for scientific research. This little craft has been constructed by Dr. H. H. Dukes, professor of veterinary physiology, in his experiments in measuring metabolic rate at different temperatures. Not only have several big mother hens been induced to take long voyages in it, but they have proved to be very good sailors.

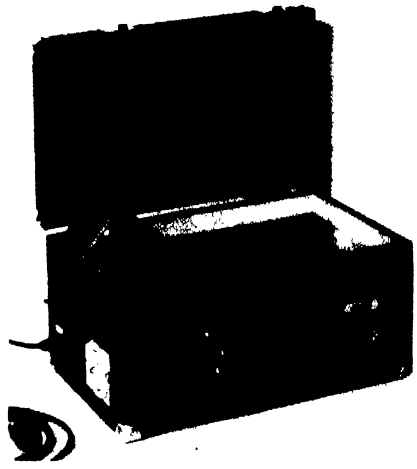
The "ship" is not only as completely air conditioned with purified air as a modern house, but it has a glass window in the side through which, when the little lid is raised, the hen may view with wonder the marine marvels to be found in a barrel of water. The chicken, when inside, is mounted upon a movable platform by which her slightest movement is recorded upon a smoked paper graph outside. Contrary to what might be expected, the chickens remain surprisingly calm and sleep most of the time in the night-like darkness of the submerged submarine.

Eight or ten hens work in shifts during the time the apparatus is in use. Each bird remains submerged from 14 to 18 hours, during which time she is subjected to varying degrees of temperature, corresponding to all the seasons. By starting with ice water and gradually raising the temperature to what would be summer heat, the hen can be observed under all conditions of weather. Though human beings under such a variety of temperatures would be uncomfortable, the chicken, says Dr. Dukes, is quite comfortable.

The real object of the experiment is, however, to measure accurately the metabolic rate of the hen, or the amount of fuel burned by her body under different conditions of environmental temperature. The gases given off by the body are trapped by means of the air-conditioning system, and are measured accurately. By this means Dr. Dukes will be able to determine the amount of food necessary to maintain the hen efficiently, and from this he hopes to be able to ascertain whether it is cheaper for the chicken farmer to heat his chicken houses or feed the birds more during the cold winter months.—*Science Service.*

Photo Copying Device

ONE of the latest developments in photo copying methods is the new portable, electrical Copyst, which makes prints similar to photostats but considerably less expensive. It reproduces facsimile copies of anything, whether written, drawn, stamped, or printed, whether loose or bound in a book, whether transparent or opaque.



Self-contained copying unit

The apparatus is a simple photo-printer compactly built into a box carrying all the equipment necessary. It comes in several sizes and can be operated by an inexperienced clerk in ordinary office daylight without the use of a dark room. The process uses a photographic paper of very low general sensitivity.

Inside the box there are no lenses or prisms, the copies being made of a size equal to the original by contact printing or reflected light. The sensitized paper is cut from a roll and mounted in a holder in the top of the box. The copy to be reproduced is placed also in the holder against the sensitized paper. A small portable electric dryer is included with the equipment and completes the process.

Duck Inventory With Hundreds Making Counts

THE second annual inventory of migratory waterfowl spending the winter in the United States, which was completed in January, was extraordinary in the completeness of its organization. The inventory, under the direction of the Bureau of Biological Survey, was made after long planning and with the largest number of qualified observers ever assembled. The country-wide census was completed in just two days.

Eight regional directors of the Division of Game Management assigned estimators to survey definite areas by ground, water, or air. In addition to the regular field per-

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sonnel of the Survey (United States Game Management Agents, District Agents, Refuge Managers and Superintendents, Wildlife Technicians, and others), observers were augmented by state game wardens, personnel from the Forest Service, the Soil Conservation Service, the Bureau of Public Roads, state police officers, observers from certain state colleges, and volunteer observers from the regular list of the Survey, and from the membership of the National Association of Audubon Societies.

Many observers operated by automobile. The "navy" of patrol boats of the Biological Survey was greatly enlarged by patrol craft of state game commissions, by boats of the Bureau of Navigation and Steamboat Inspection, patrol vessels of the Coast Guard, and by many privately owned power boats.

The Navy Department, the Coast Guard, and the Connecticut National Guard furnished land planes or seaplanes, and a few interested civilians contributed the use of aircraft, so that all coastal areas were surveyed from the air as well as from the land or water. The War Department furnished a blimp, the *TC-13*, stationed at Moffet Field, California. The blimp *Enterprise* surveyed the Potomac River from Washington, D. C., to Point Lookout.

Frederick C. Lincoln, biologist of the Survey who directed the inventory, had eight field armies and a couple of navies thrown in for good measure.

Regional Director W. M. Rush, at Portland, Ore., reported 106 observers for his region, including men from his own office, the Forest Service, three State Game Departments, a state college, and several volunteer operators, not to mention automobiles, power boats, seaplanes, and the *TC-13*.

Regional Director Bertrand E. Smith, at Portland, Maine, had about an equal number of observers, with Coast Guard Patrol boats, cutters, and seaplanes from Cape May, New Jersey; Salem, Massachusetts; from the Navy airports on Long Island, New York and Chatham, Massachusetts; and from the air service of the Connecticut National Guard.

These "sample" forces were equalled or beaten in numbers and variety of craft by a number of other districts. Two biologists of the Survey worked in the waterfowl areas of Mexico. When all reports have been analyzed, the Bureau hopes to have available a reasonably accurate estimate of the continental supply of waterfowl, most of which will shortly be starting the long flight to their nesting grounds.

Stretchable Lacquer Finish

A "STRETCHABLE" lacquer finish, claimed to rival the flexibility and distensibility of rubber itself, is noted in *The Rubber Age*. Tests conducted on this new lacquer showed that when applied on a piece of live rubber, and both stretched to the limit, the finish remained intact.—*A. E. B.*

Bad News for Unscientific "Collectors"

BY a resolution of the State Legislature of Nebraska, police powers over sites of archeological and paleontological interest have been conferred, says the magazine *Nature*, on the State Geological Survey, which will enable that service to control the future collection of antiquities and fossil bones, for which the state is widely known as a favorable locality. Although the efforts of the National Research Council have done much to make widely known among the people of the United States the desirability of preserving intact their monuments of antiquity, up to the present only a few of the states have taken legislative action to protect them; and should the measures adopted in Nebraska prove effective, it is anticipated that other states will follow this example before long.

As recent investigations have shown, Nebraska and the neighboring states of the southwest are rich in relics of early man and of the extinct fauna with which, it would appear, early man was associated in this part of America; but this wealth of material has proved an irresistible attraction to the amateur collector and the curio hunter, with the result that much important scientific evidence has been lost or destroyed by the removal of specimens from their stratigraphical context without adequate record, or indeed, in many instances, with no record at all.

Some indications of the extent of the loss that science has suffered in this way is afforded by the references to important archeological specimens in private hands scattered throughout the records made by Prof. E. B. Renaud's archeological surveys of Colorado and adjacent territories. It has been specifically stated on behalf of the Geological Survey that there is no intention to restrict duly accredited scientific research. [See also page 177. *Ed.*]

Belgian National Park More Than Doubled in Size

BELGIUM'S great national park in the heart of Africa, where dwell gorillas and many other strange and rare beasts and birds, has been more than doubled in size by recent governmental decree. Its total area now comprises nearly 857,000 hectares, or almost 2,500,000 acres.

The new extension includes Lake Edward and a number of smaller lakes, a large area in primitive equatorial forest, and Mount Ruwenzori, where perpetual snow lies on the equator.—*Science Service.*

Devilfish, Barnacles, Seaweed Eaten by Indians

PEOPLE will eat queer things, if they have to—or if they happen to like them. The diet of the Pomo Indians of the California coast once included such marine delicacies as devilfish, barnacles, sea-urchins, sea-anemones, sea-cucumbers, and various kinds of seaweed, besides such more familiar items as lobsters, crabs, mussels, and abalone, according to *Science Service*.

Altogether, 15 seashore animal species and three kinds of marine plants were eaten by these Indians, Omer C. Stewart of the University of California has learned. His investigations included questioning aged members of the tribe, and digging in the refuse mounds left by many generations of feasters.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

WHERE TO BUY, RENT, AND BORROW SILENT AND SOUND-ON FILM, 16 MM. FILMS, is a 100-page booklet that will be valuable to educational and other institutions where motion picture equipment is available. *Write for Bulletin 436M to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

TEN FACTS ON TECHNOLOGY AND EMPLOYMENT is a notable attempt to prove that machinery is a creator of jobs rather than a destroyer of employment opportunities. Ten pages of sound reasoning. *Write for Bulletin 436L to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

EVIDENCES OF RECOVERY is a single sheet graph 16 x 15 inches showing business activity, construction volume, and wholesale prices of various commodities from January 1932 to December 1935, giving a comprehensive picture of the industrial situation in the United States. *Write for Bulletin 436E to Scientific American, 24 West 40th Street, New York City. 3-cent stamp.*

LESSONS FROM DUST EXPLOSIONS is an illustrated pamphlet of 78 pages, plus an appendix, which surveys the record of dust explosions during the past four years. It is of exceptional value to all those interested in plant design and management. *Write for Bulletin 436F to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

A RUBBER PLANTATION IN NEW JERSEY is a nicely bound little booklet telling of the development of Thiokol, the first commercial synthetic rubber produced in the United States. The book gives some of the chemical background of the development and tells specifically of the uses which it finds in industry. *Write for Bulletin 436B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE PROPER USE OF EXPOSURE METERS, by Joseph M. Bing, F. R. P. S., is a small, compact pamphlet of 12 pages which gives pertinent data on the subject. It includes a practical list of speed values in the Scheiner scale. *Write for Bulletin 436A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

PROGRAM SOUND SYSTEM describes a newly developed public address system designed for use in schools, hospitals, hotels, department stores, and so on, where it is desirable to keep a large organization in constant touch with some one particular department or office. *Write for Bulletin 436D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

TELEPHONE ALMANAC FOR 1936 is an attractive little booklet, prepared in the style of the old-fashioned but familiar almanac, which is particularly concerned with the development and present status of telephone communication. *Distributed upon the request of telephone subscribers through the local telephone companies of the Bell System.—Gratis.*

THE MODERN OFFICE BUILDING is a brief pamphlet describing the windowless office building—construction, air conditioning, lighting, furnishings, and so on—of the organization which distributes it. *Hershey Chocolate Corporation, Hershey, Pa.—Gratis.*

A GUIDE BOOK FOR WILLIAMSBURG, VIRGINIA, is a well presented little booklet of 48 pages, giving brief yet comprehensive descriptions of all of the points of interest in the historical town of Williamsburg. It also reviews the history of the community and presents a useful guide map. *Colonial Williamsburg, Inc., Williamsburg, Virginia. —25 cents.*

MICROSCOPE EQUIPMENT FOR THE AMATEUR is an illustrated leaflet describing all types of microscopic equipment from the lowest price to the highest. *Write for Bulletin 436C to Scientific American, 24 West 40th Street, New York City. 3-cent stamp.*

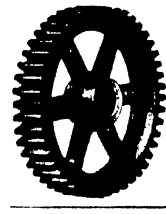
WINE MAKING AND BRANDY PLANTS is a handbook of information relative to the present status of the wine industry and of fruit spirit distillation, designed for distribution to field engineers in this particular industry. *Write for Bulletin 436G to Scientific American, 24 West 40th Street, New York City.- 3-cent stamp.*

CONTROL is a message to the transportation industry, concerned specifically with the brakes used on present-day automobiles. It surveys critically the service to which motor car brakes are subjected and points out solutions to some of the problems. *Write for Bulletin 436K to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

NATIONAL PARKS OF CANADA, ANNUAL REPORT OF THE COMMISSIONER OF NATIONAL PARKS, is a beautifully presented booklet of 64 pages, illustrated with several photographs, telling of the work accomplished by the Commission during the fiscal year ending March 1935. *Department of Interior, Ottawa, Canada.—Gratis.*

NUTRITIONAL CHARTS is a 28-page booklet giving vitamin data and information on mineral nutriments, composition of common fruits, cereals, nuts, poultry and dairy products, and miscellaneous foods. For medical, dental, dietetic, and food specialists only. *H. J. Heinz Company, N. S., Pittsburgh, Pa. —Gratis.*

WINDSTORMS, THEIR CAUSES AND EFFECTS, is a survey designed for use by special insurance agents as a desk-reference pamphlet, but will be of value to anyone who is interested in the destructive effects



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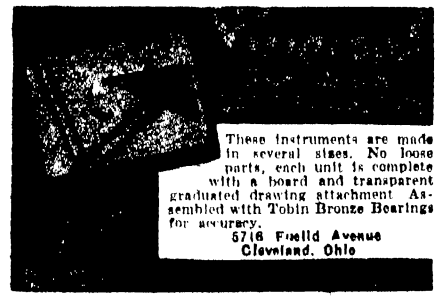
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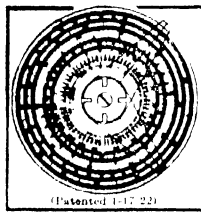

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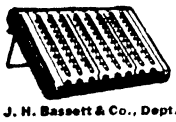

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TRISECTING THE IMPOSSIBLE

(Continued from page 191)

equation are said to be rational if they can be expressed without the use of radical signs. By way of illustration, 3, $\frac{a+b}{c \times d}$, $\sqrt{d^2}=d$, and the root of $ax+b=0$, are all rational; whereas $\sqrt{2}$, $\frac{a+\sqrt{b}}{\sqrt[4]{c}}$ and the roots of $x^2-3x+1=0$ are all irrational. All the square roots which we have indicated so far have been real square roots, the radical operating on a positive number. A number such as $\sqrt{-3}$ *is said* to be an imaginary number, and $2+\sqrt{-5}$ is called a complex number. These latter are not included in the usual number system of real numbers.

With this understanding of the meaning of terms, we assert without proof[2] the very important theorem:

Theorem: By ruler and compasses it is possible to construct only those points whose coordinates are expressible in terms of the coordinates of the given points as functions involving a finite number of rational processes and extractions of real square roots, and all such points can be constructed.

By this theorem we see that, if we have given us the points $(3,0)$, and $(\pi,0)$ we can construct $(2\pi,0)$ and $(2\pi+3,0)$ but we cannot construct the point $(\sqrt{-3},0)$.

The Trisection of An Arbitrary Angle: In the preceding theorem we have summarized what it is possible to do with ruler and compasses alone, the only tools allowed

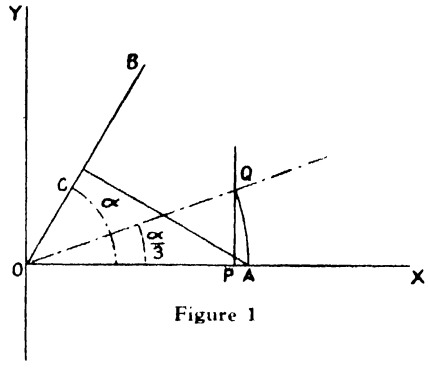

Figure 1

in Euclidean geometry. It remains for us to prove that there are angles which cannot be trisected, thereby proving that a construction to trisect an arbitrary angle is impossible.

In order to effect this proof, we shall have to express the trisection problem in terms of analytical geometry. Let us suppose, therefore, that angle AOB, see Figure 1, is the angle to be trisected. Let us choose OA to be the unit of length along the X-axis. Construct AC perpendicular to OB. By the definition of the cosine of an angle (see any book on trigonometry) we have at once cosine of angle $AOB = OC/OA = OC$, since $OA = 1$

There is an important relation between the cosine of an angle and the cosine of one third the angle which will be found in any book on trigonometry, namely, $\cos.\ \alpha = 4\cos.\ (\alpha/3) - 3\cos.\ (\alpha/3)$, in which α is an arbitrary angle. If we multiply both sides of this equation by 2, and set $x = 2\cos.\ (\alpha/3)$, we obtain $x^3 - 3x - 2\cos.\ \alpha = 0$ by transferring all the terms to the same side of the equation. Provided we can solve this equation by ruler and compasses (that is, provided we can construct $x = 2\cos.\ \alpha/3$), we can trisect angle α as follows: The construction, be what it may, will yield us the point $(2\cos.\ \alpha/3,\ 0) = P'$ on the X-axis, from which we can construct the point $(\cos.\ \alpha/3,\ 0)$ by bisecting OP'. Therefore, for the present we will assume that we have located a point P on the X-axis such that the distance OP, the distance from the origin to P, equals $\cos.\ \alpha/3$. Through P we draw a line parallel to OY, and with OA $(=1)$ as radius and O as center we describe an arc cutting the parallel through P at Q. By this construction we have $OA = OQ = 1$ and, therefore, from the definition of a cosine, we have constructed $\cos.\ POQ = OP/OQ = OP = \cos.\ (\alpha/3)$. Therefore angle POQ is one third of angle α, in this case angle AOB, which was an arbitrary angle, and so we can trisect an angle by using P, *if we can locate it.*

We shall now show that it is impossible to trisect a 60° angle with ruler and compasses alone. Every angle in an equilateral triangle is 60°, and a perpendicular from a vertex to the opposite side divides an equilateral triangle into two right triangles, from which it is easy to verify that the cosine of 60° is ½. Substituting this value for $\cos.\ \alpha$ in the equation in x previously obtained, we get (1) $x^3 - 3x - 1 = 0$, the critical equation of our study. Has this equation a rational root?

A *real* root of this equation may be represented as a point on the X-axis and if it is to be rational it must be either an integer (whole number) or a fraction (whose numerator and denominator we can assume, without loss of generality, have no common factors). Let us take it to be $x = a/b$, where a and b are integers having no common factor greater than unity. Substitution in (1) yields $\frac{a^3}{b^3} - \frac{3a}{b} - 1 = 0$. Multiplying through with b^3 and transposing two terms, yields $\frac{a^3}{b} = 3ab + b^3$ and the right side of this

[2] For a discussion of points constructible with a ruler alone, and with ruler and compasses only, see H. P. Hudson: "Ruler and Compasses" (1916).

equation is an integer, since a and b are both integers by assumption. This means that a^3/b is an integer, which can occur (1) if a and b have a common factor, or (2) if $b = \pm 1$. Since the former is contrary to hypothesis, then for a rational root to exist we must have b equal to either $+1$ or -1, which means that *the rational root, if it exists at all, is an integer and not a fraction.*

Denoting the left side of equation (1) by $f(x)$, and substituting the values x equal to -2, -1, 0, 1, and 2 respectively, we find

$$f(-2) = -3$$
$$f(-1) = 1$$
$$f(\ 0\ ) = -1$$
$$f(\ 1\ ) = -3$$
$$f(\ 2\ ) = 1$$

and, noting the changes in sign of $f(x)$, we see that the three roots of (1) lie between -2 and -1, -1 and 0, 1 and 2, respectively. Since a cubic can have only three roots we see that all three roots are real and must either be fractional or irrational. But we showed above that if (1) possesses a rational root it is an integer, and therefore the fractional possibility is eliminated and we can assert with certainty that *all the roots are irrational.*

Has (1) a root expressible in terms of rational numbers and real square roots; that is, has it a constructible root?

By utilizing various properties of radicals it can be shown[3] that *if a cubic equation possesses a root expressible in terms of rational numbers and real square roots, then it also possesses a root expressible as a rational number alone.* From this we conclude that if a constructible root of (1) existed, then there would exist also a rational root. Since we found that no rational root existed, we conclude further that *our equation has no root constructible by ruler and compasses, and we cannot trisect a 60° angle with these tools alone.*

This proves conclusively that it is impossible to trisect an arbitrary angle with ruler and compasses only.[4]

SOME Other Impossible Constructions: In the foregoing we have demonstrated that it is impossible to trisect a 60° angle, which implies, of course, that we cannot construct a 20° angle with ruler and compasses alone. A little further thought will show that a 40° angle is also one of those which cannot be constructed, for if we could construct a 40° angle we could construct the 20° one by bisecting it. Therefore, it is clear that *a regular polygon of nine sides cannot be constructed by ruler and compasses,* since the angle at the center subtended by a side is 360°/9, or 40°.

By utilizing certain trigonometric relations it can be shown[5] that the construction of a regular polygon of seven sides depends on the equation $x^3 + x^2 - 2x - 1 = 0$. By following through the very same procedure as above, step by step, we find that this equation has no rational root and, indeed, no root expressible in terms of rational numbers and real square roots. Consequently, *we cannot construct a regular polygon of seven sides with ruler and compasses alone.*

As a concluding demonstration we shall give a construction which trisects an arbitrary angle, and is typical of many of those which afford "news" from time to time, in that it involves a simple step which is, however, *not in accord with the rules of the game.* To begin, we assume that the problem has been solved, and that the line OT (Figure 2) is such that angle TOB = half angle

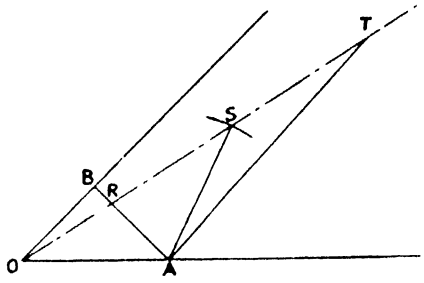

Figure 2

TOA. From any point A on one arm of the angle we draw a parallel and a perpendicular to the other arm. Describing a circle about A, with radius OA, we locate S on the trisecting line such that $AS = OA$. From the diagram we easily verify the following relations: angle AOS=angle ASO=angle SAT+angle STA and angle AOS= 2 angle TOB=2 angle STA. Consequently angle STA=angle SAT, giving ST=SA. Moreover, angle SAR=angle SRA, complements of equal angles. Consequently SA=SR, so that TR=$2OA$. This gives us the construction: Choose any point A, on either arm of the given angle, and draw a line parallel and a line perpendicular to the other arm. Now, with one end of the ruler at O, turn the edge until the intercept between the perpendicular and the parallel equals $2OA$. This requires *measuring* (that is, either a scale or a sliding length equal to $2OA$ on the ruler) *and we are not permitted to measure with a ruler in plane geometry.* Our ruler is to be a straight-edge with which to construct straight lines—that is all. This construction is simple, interesting (and may be useful) but, like all the rest, it does not obey the rules of the problem.

To attempt to discover such a solution is a waste of time and effort for, as we have shown, it is insoluble.

BIBLIOGRAPHY

The present proof has been arranged from material to be found in the following:

L. E. Dickson: "Elementary Theory of Equations" (1914).

"On the Trisection of An Angle," *American Mathematical Monthly,* Vol. 21 (1914).

And a similar article in *Mathematics Teacher,* Vol. 14 (1921).

H. P. Hudson: "Ruler and Compasses," (1916).

Other References: W. W. Beman and D. E. Smith: Authorized translation of "Klein's Famous Problems of Elementary Geometry" (1897). [This book is now out of print.—Ed.]

L. E. Dickson: a section on constructions with ruler and compasses in "Monographs on Modern Mathematics," edited by J. W. A. Young (1911).

"Modern Algebraic Theories" (1930).

[3]See L. E. Dickson: "On the Trisection of An Angle," *Amer. Math. Monthly,* Vol. 21 (1914), and a similar article by the same author in *Mathematics Teacher,* Volume 14 (1921).

[4]We are able to trisect certain angles, for example 180°. In these cases the equation which corresponds will be found to have a rational root. For 180° we have *cos.* 180= -1, giving the equation $x^6-3x+2=0$, which has a root $x_1=1$.

[5]See L. E. Dickson, "On the Trisection of An Angle," referred to above.

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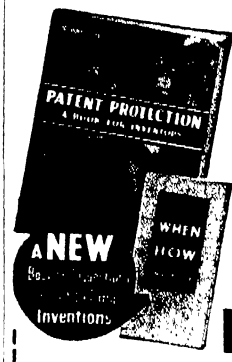

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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COVER

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WELDING is becoming of vastly increasing importance to industrial operations throughout the world. Our cover photograph shows just one of the many applications that are discussed in complete detail in the article starting on page 244.

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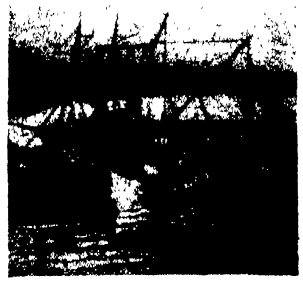
50 Years Ago in . . .

Scientific American

(Condensed From Issues of May, 1886)

PANAMA CANAL—"When M. De Lesseps and his party inspected the Panama Canal, in February, they were accompanied by Mr. John Bigelow, as the representative of the New York Chamber of Commerce. Mr. Bigelow states that it is impossible to say what the final cost of the work will be, or when it can be completed. Mr. Bigelow regards the canal as an undoubted possibility if sufficient funds be provided, but he ventures no opinion as to whether they will be, or what sum or what amount of time would be necessary to complete the work."

DEEP FOUNDATION—"The location of the Hawkesbury River railroad bridge near Sidney, Australia is one that demanded extraordinary work, not in regard to the superstructure, but in relation to the foundations for the piers. The total height from the bottom of the piers to the rails will be 227 feet. Sinking piers to such a great depth has never been attempted, even in this age of wonderful engineering. Like most of the methods of American engineers, the chief characteristic of these plans, as now contemplated, is simplicity. The outer tube of the caisson is oblong in plan, being 20 feet wide by 48 feet long. Within the outer tube are placed, at equal distances apart, three cylinders or dredging tubes, 8 feet in diameter. The lower part of these tubes is extended to meet the cutting edge. The space between these tubes will be filled with concrete as the cylinder sinks. After the cylinder has reached a solid resting place, the three inner dredging tubes will also be filled with cement, thus making a pier of solid cement from the bottom to the water level."



GAS TANKS—"The famous South Metropolitan Station gas holder, of London, 214 feet in diameter, over 150 feet high, and 5,500,000 cubic feet capacity, long held its position as the largest in the world. It has now been eclipsed by a pair of holders erected recently at the Birmingham (Eng.) Corporation Gas Works. Each of these is contained in a tank 240 feet in diameter, is said to be 150 feet high, and to hold 6,400,000 cubic feet."

SAW—"A saw without teeth, that will cut a steel rail in two minutes, is in operation at the Central Hudson shops, in Greenbush, N. Y. The disk is made of Bessemer steel, and runs at a very high rate of speed. While in operation a band of fire encircles the saw, and the many sparks flying from the revolving disk resemble a display of pyrotechnics. A small stream of water cools the saw while in motion. By this plan one saw will cut nearly 3000 rails before it is worn out."

STAMPS—"Mr. Patrick Chalmers, of Wimbledon, has issued a pamphlet claiming that his father, James Chalmers, bookseller, Dundee, was the inventor, in the month of August, 1834, of the adhesive postage stamp."

SPANISH WARSHIPS—"The Spanish Government have contracted with Messrs. Yarrow & Co., of Poplar, for the construction of two first-class torpedo boats of the *Falke* type. The speed in fighting trim, carrying 17 tons on board, is guaranteed to be 23 knots, and when running light 25 knots, or about 26¼ and 28½ miles per hour."

HEALTH—"The great question of the day is not this operation or that, not ovariotomy or lithotomy, or a hip joint amputation, which have reflected so much glory upon American medicine, but preventive medicine, the hygiene of our persons, our dwellings, our streets, in a word, our surroundings, whatever or wherever they may be, whether in city, town, hamlet, or country, and the establishment of efficient town and state boards of health."

"AMERICA'S" CUP—"The yacht *Atlantic* was successfully launched on May 1. The new clipper has been built after the designs of Captain Philip Ellsworth by a syndicate of yachtsmen composed of prominent members of the Atlantic Yacht Club. The purpose of her existence is the defense of the *America's* cup, for which the British cutter *Galatea* is now the avowed competitor."

GUN MOUNTS—"Captain W. H. Bixby, Corps of Engineers, U. S. Army, proposes to replace the present slowly built, difficultly moved, difficultly releveled masonry foundations for heavy guns behind earthen parapets by rapidly constructed, easily moved, easily releveled wrought iron foundations, to rest on cross girders or sleepers embedded in the earth of the *terre-plein*, and provided with a front parapet anchorage sufficient to resist all direct recoil."

ELECTRIC WORKS—"The remarkable inventions of Mr. Charles F. Brush have been made available and remunerative by the Brush Electric Company, who are the sole owners of all his patents. This combination of inventive genius and business sagacity has, within the last decade, done much to revolutionize the artificial illumination of the world, and built up a business in whose various branches more than $25,000,000 are now invested. The entire area occupied by the buildings is about seven acres. In the main shop are manufactured the dynamos, arc lamps, and indeed all other apparatus requiring the use of machinery. The heavier machines, such as the planers, drill presses, lathes, some of them being very ponderous, are all placed on solid stone foundations."

TELESCOPES—"A long article is contributed to *Ciel et Terre*, in which the writer maintains that the real inventor of the telescope was John Lippershey, a spectacle maker at Middleburg (Netherlands), who was born in Wesel, Germany. James Metius, who, according to Descartes, has been regarded as the inventor, wrote on the 17th of October, 1608, to the Provinces of Holland, stating that he, *as well as* the spectacle maker of Middleburg, was manufacturing the instrument that brings objects near."

AND NOW FOR THE FUTURE

¶The Truth About Smoking: A Critical Summary of Scientific Findings.

¶Calling on the Black Widow Spider: Intimate Observations of Her Home Life.

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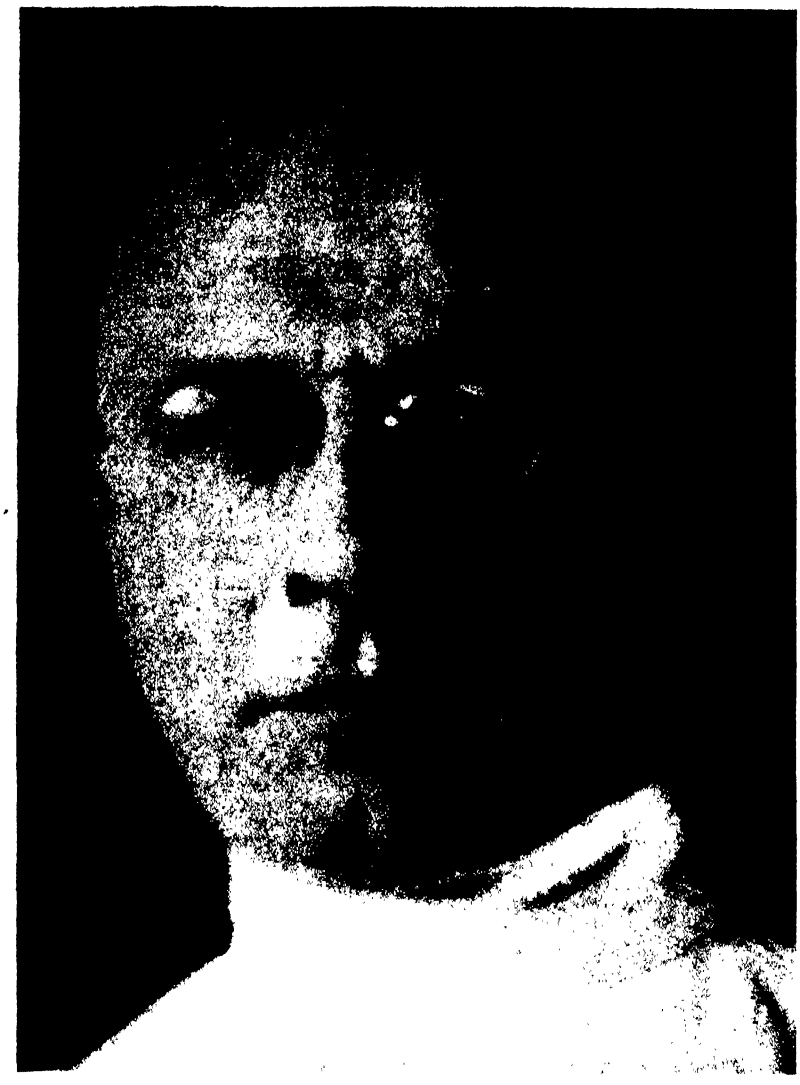
¶Accomplishments of Amateur Telescope Makers: Some of the Excellent 12-Inch Instruments Produced.

¶Engineering Activities at the Site of the Fort Peck Dam Now Building.

Personalities in Science



DR. ALEXIS CARREL

STRETCHED along several blocks of Manhattan's eastern waterfront is a semi-isolated string of low buildings whose corridors smell of antiseptics. Here, near the heart of a great community, yet strangely detached from its noise and too vibrant atmosphere, a corps of white-coated biologists of plain appearance and simple manner works day by day on some of the more fundamental problems of biology and medicine—problems often of the kind which cause unintelligent men and women to throw down their newspapers in disgust and ask what earthly good could come of such absurd experiments.

But the Rockefeller Institute for Medical Research does not explain. It does not need publicity, and is beholden only to the fact that it knows what it is doing. All its energies are turned, instead, to the prosecution of its work. Later on, the outcome of the "absurd" experiments, trickling down through to physicians, will doubtless touch that same man and woman's lives in some vital, practical way, and if that happens, perhaps it is enough. In science, one advance cannot be pursued with much hope of success until previous "log jams" are unsnarled. The Rockefeller Institute's business is to unsnarl log jams.

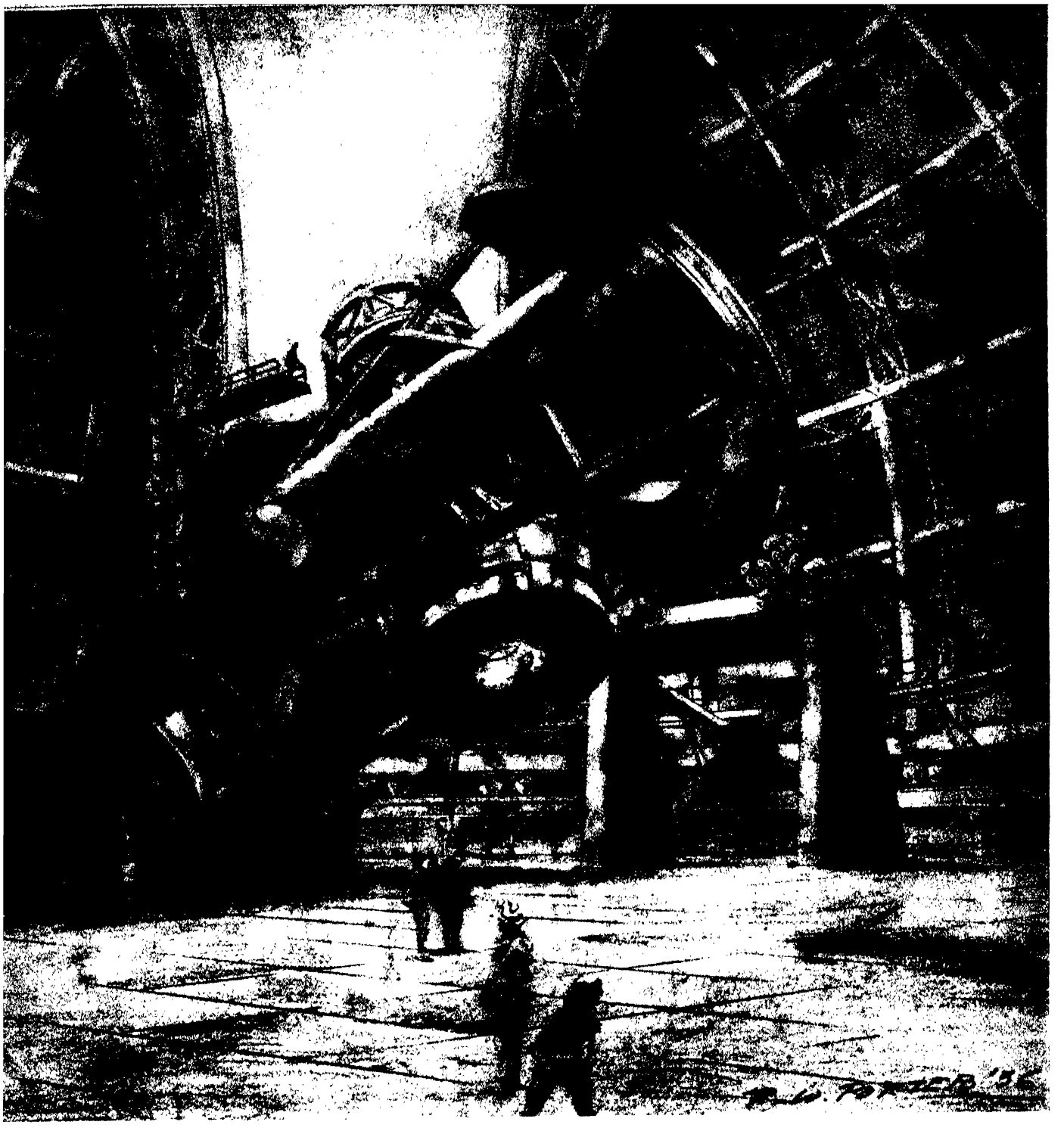
Among the scientists at "The Institute," none is so very widely known, so frequently discussed, none has become such a tradition in the outside world, as a stocky, brachycephalic Frenchman, Dr. Alexis Carrel, whose age will shortly be 63. Yet seldom is Dr. Carrel seen in public life. His work is done in quiet and modest simplicity. In "American Men of Science," the special who's who of the scientific world, Dr. Carrel's life work is summarized in a mere 7½ modest lines—less than many a lesser man—for he wrote the summary himself. He states his special interests in science simply as "experimental surgery; biology." Each of these covers a vast territory.

"Chicken hearts—isn't he the scientist who has kept a chicken's heart alive for ten years?" This is what the average man most quickly links with Dr. Carrel. But the truth is that Dr. Carrel has kept a chicken heart not only alive but beating in a glass tube of nutrient solution, and constantly growing, for 24 years, 3 months. That small, famous portion of chicken giblets seems to be well on its way to immortality, both in a literary and literal sense.

But such experiments are more—far more—than an interesting stunt; they throw significant light on two big problems, one purely scientific, the other purely practical. The biggest, likewise the most fascinating, problem of biological science is to answer that baffling question, "What is life?," also its corollary, "Is life a purely physical and chemical phenomenon or is it something more (vitalism)?" Secondly, the practical, immediate problem of human beings growing old. Just what is growing old, anyway? More facts must be learned before we can fully answer this question, but Dr. Carrel has done this much: by introducing different chemicals into those bits of tissue of which he has several which are junior to the one aged 24 years, he found not only how tissues grow old, but evidence that indicates that if tissues were kept cleansed of waste, they would never grow old.

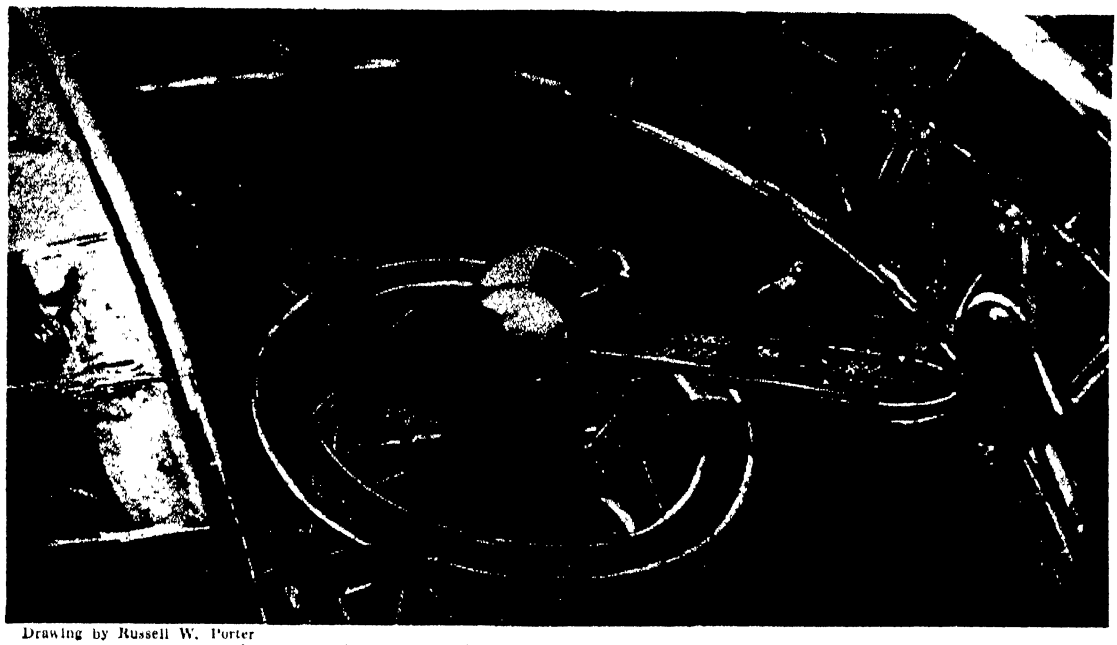
In 1912 Dr. Carrel received the Nobel Prize for Medicine in recognition of his technique for growing tissues outside of the body. His researches point to the future possibility of transplanting live ofgans from one organism to another. As we do not die all over at the same instant, some organs outliving others by minutes or hours, and the skin sometimes by still longer, organs may some day be transplanted from persons who have died in part to living persons who require new ones.

Researches like these dig deep into the very foundations of things. They are basic. And they sometimes change history.



TENTATIVE SKETCH OF THE 200-INCH TELESCOPE

THE above sketch, made by R. W. Porter after the latest engineering designs under consideration, gives the best idea now available of the probable appearance of the 200-inch telescope. A one tenth scale steel model of this type, built in the Instrument Shop of the California Institute, is nearly ready for rigorous tests for flexure, torsion, and so on. Bearing tests are already under way. The telescope tube will be more than 20 feet in diameter and 60 feet long, stiff enough to carry an observer at the upper end without flexure. As the total weight of the moving parts will be about 425 tons, the perfection demanded of the bearings, driving mechanism and all controls and auxiliary apparatus is obvious. The telescope will be suitable for many classes of work. Probably its chief use will be for the study of the faint extragalactic nebulae and the spectroscopic investigation, with the highest dispersion, of the brighter stars of our own galaxy.—*George E. Hale.*



Drawing by Russell W. Porter

Changing observers at the primary focus of the 200-inch telescope

THE 200-INCH TELESCOPE

Observatory Design . . . A New Astrophysical Observatory . . . The Great Reflector . . . Auxiliary Devices . . . Purpose of the New Observatory

By GEORGE E. HALE

Honorary Director, the Mount Wilson Observatory of the Carnegie Institution of Washington. Chairman of the Observatory Council of the California Institute of Technology

IT was an oppressive August evening at Rochester in 1892, and a group of us had flocked out on the sidewalk, to escape the hot rooms of the hotel. A prominent figure in the company was Alvin G. Clark, who still carried on his father's well-known optical shop at Cambridgeport. He was telling of a recent experience, to which I listened intently. A plan for a large refracting telescope in Southern California had failed for lack of funds. However, the excellent 40-inch disks of optical glass, ordered for this purpose from Mantois some years before, had been completed and were then in Clark's shop. Did anyone know of a purchaser?

I had come down to the American Association meeting from the Adirondacks, where my wife and I were spending a short vacation. Fly-fishing for trout, though a favorite sport, had not been entirely free from dreams of a large telescope, which I needed to pursue my plans for solar research. We had visited the Lick Observatory two years before, and I was still under the spell of the great 36-inch refractor, first dimly seen reaching toward the heavens in a huge dome lit only by the comparison spark of Keeler's spectroscope, with which he was engaged in his classical researches on the radial motions of the planetary nebulae.

I had been offered the use of the Lick telescope at that time for the development of the spectroheliograph, which I had begun at my small spectroscopic laboratory and observatory at Kenwood (Chicago) in the previous year. But the installation of a 12-inch refractor at Kenwood seemed the wiser plan, and with this the spectroheliograph was completed and brought into daily use for the photography of the solar prominences and the calcium flocculi early in 1892.

AFTER hearing Clark's story I lost little time in returning to Chicago, where I combed the financial district in vain. However, a suggestion by Mr. Charles Hutchinson, a trustee of the nascent University of Chicago, led to a visit by President Harper and myself to Mr. Charles T. Yerkes, who promised to give the 40-inch objective, subsequently a Warner & Swasey mounting, and finally a building at Lake Geneva for the Yerkes Observatory. As one of the comparatively few surviving members of the first faculty of the University, I look back upon this experience with pleasure, in spite of the troublesome task of raising the funds for site, equipment, and maintenance.

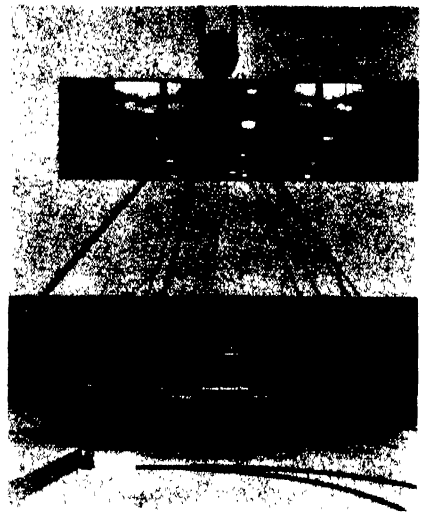
This task was essentially completed in 1902, when a new possibility presented itself. The Carnegie Institution of Washington, established in that year, considered several projects in astronomy. One of these was an astrophysical observatory, for which a committee of three (Lewis Boss, Campbell, and the writer), selected a provisional site on Mount Wilson, near Pasadena. As a special gift, expected by the trustees for this purpose, did not then materialize, I began some inexpensive experiments on the mountain in the winter of 1903-04, with instruments borrowed from the Yerkes Observatory. The results led the trustees to appropriate 10,000 dollars for a continuation of the work. A few months later further funds became available and the original project was provided for.

How to design an observatory, whether large or small, is a many-sided problem. I had encountered it in elementary

form as a boy, when I began my first amateur work in chemistry, physics, microscopy, photography, spectroscopy, and astronomy. Each of these subjects delighted me, and I have found all of them of use in later life. Concentrating my attention when about 15 on spectroscopes and telescopes, I used my other tools and instruments, many of them home-made, as auxiliaries. The value of bringing fixed and sharply defined celestial images into the laboratory, for study with the most powerful spectroscopes I could obtain, was obvious, though this method had been little used. For certain kinds of work, however, a moving equatorial telescope, with photographic or spectroscopic apparatus attached, was more desirable. Both schemes were tested at Kenwood, and from this experience the Yerkes Observatory was designed.

THE conditions at Lake Geneva and Mount Wilson were nevertheless very unlike. The Yerkes Observatory sprang from a lucky chance, which in considerable degree determined its character. Its chief instrument must be the 40-inch refractor, admirably adapted for some types of solar and stellar research, but not suitable for others. It could not be too far from the University of Chicago, though many other possible sites within the same radius were studied before Lake Geneva, Wisconsin, was selected. Its building must be a single one, of rather ornate construction, to meet the wishes of the donor. As for its miscellaneous instrumental equipment, nearly all had to be built in our own shops, except the useful nucleus supplied from the Kenwood Observatory. The reader might be amused if I were to recount the many expedients by which small gifts were obtained. A typical instance of necessary economy was the purchase of the large portrait lenses (old Voightländer type), embodied in the Rumford spectroheliograph, from a pawnshop in St. Louis!

The staff was necessarily organized slowly, as small gifts were secured here and there for salaries. Its character was defined by the possibilities of our instruments and resources, rather than by the needs of a homogeneous and well-ordered plan of research. But we never failed to get the best men obtainable, as those who recall its composition will agree.

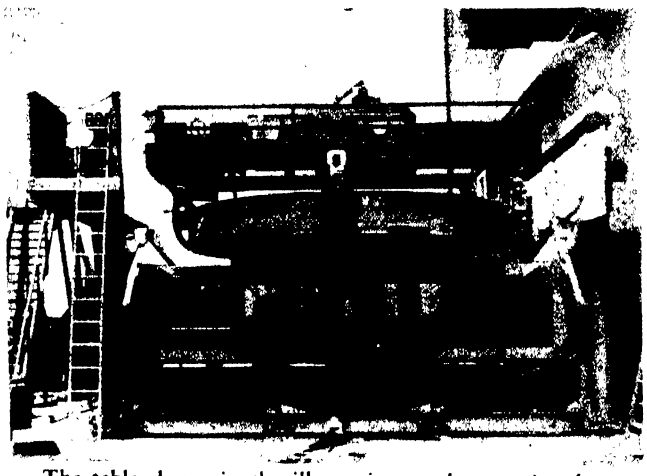


The base or turn-table on which the disk will be ground, polished, figured and tested, ready to be lifted to the spindle of machine shown below

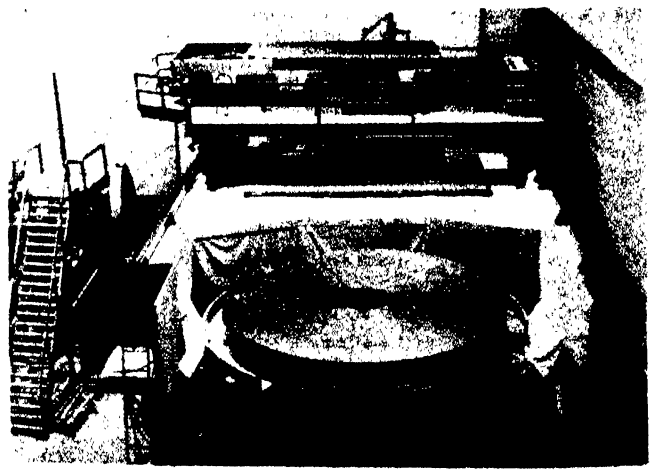
Mount Wilson offered a very different condition of affairs. The site was selected after an extensive survey in California, Arizona, and Australia, made by one of the most experienced double-star observers at the Lick Observatory. The late Professor Hussey, whose admirable report on this survey may be found in an early publication of the Carnegie Institution of Washington, knew good seeing when he found it. The initial scheme of research, worked out in a homogeneous way after 15 years of planning and investigation at the Kenwood and Yerkes Observatories, involved a physical and astronomical study of stellar evolution, giving special attention to the sun as the only star near enough to be analyzed in detail. Instead of doing what we might with a single large refractor, the various telescopes were designed to meet the observational needs in view. Novel difficulties of many kinds must be overcome, partly because of the choice of a rugged mountain, accessible only by narrow trails, and partly because of the uncertainties involved in the use of new types of instruments, such as large coelostat telescopes suitable for long exposures on the sun. Various papers in the *Astrophysical Journal* tell how these problems were solved.

Of course, as is almost invariably the case, the financial problem was the most serious, at least for nearly a year. Afterwards it disappeared for some time, until it was revived in a still more serious sense when it became necessary to find more than half a million dollars to mount and house the 100-inch mirror provided for by Mr. Hooker of Los Angeles. Later the generosity of Mr. Carnegie came to the rescue, and this telescope has proved to be the most powerful instrument of its kind.

AFTER I had felt forced by repeated illness to resign the directorship at Mount Wilson, some isolated place for continued research became necessary as my health gradually improved. I began work in a crude wooden hut on the grounds near my house, and succeeded in developing the first promising spectrohelioscope. As soon as I was able to perfect this instrument under the better conditions afforded by my solar laboratory (about the size of the old Kenwood Observatory), erected for me on the edge of the Huntington estate, I realized its new possibilities. Hence the designs of spectrohelioscopes published in Scientific American and the improved standard form described in the *Astrophysical Journal*. This comprises a complete small solar observatory, and is in daily use by amateurs and professionals in many parts of the world. It is mentioned here because it illustrates some of the possibilities of



The table shown in the illustration at the top, in place on the large machine in which the mirror will be made



The working mechanism of the machine, run off, showing the turn-table (ultimately to be the base of the telescope)

small special instruments for productive research.

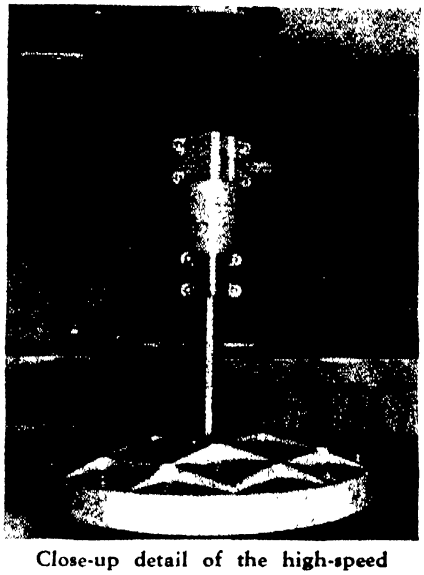
In 1927 I was asked by the editor of *Harper's Magazine* to contribute an astronomical article. "The Possibilities of Large Telescopes" seemed an attractive subject, so I described some possibilities suggested by the Mount Wilson experience. A proof of this paper, sent to Dr. Wickliffe Rose, then President of the General Education Board, led within a few weeks to a gift to the California Institute of Technology for a 200-inch telescope and a complete astrophysical observatory, with laboratories, shops, and auxiliary equipment.

Although I had been a trustee of the California Institute for many years, I was still a member of the Mount Wilson staff, and had not the faintest idea of establishing a new observatory for the Institute when I wrote to Dr. Rose. I had hoped that the 200-inch, if it could be obtained, would be given to the Carnegie Institution for the use of the Mount Wilson Observatory, but Dr. Rose thought otherwise. The Carnegie Institution and the California Institute had worked in co-operation for years, but it could not be denied that the needs of the graduate school of the Institute, combined with the facilities offered by its very able staff and its physical and chemical laboratories, offered new and promising possibilities. However, if another observatory was to be provided, a special problem of organization and design was evidently called for.

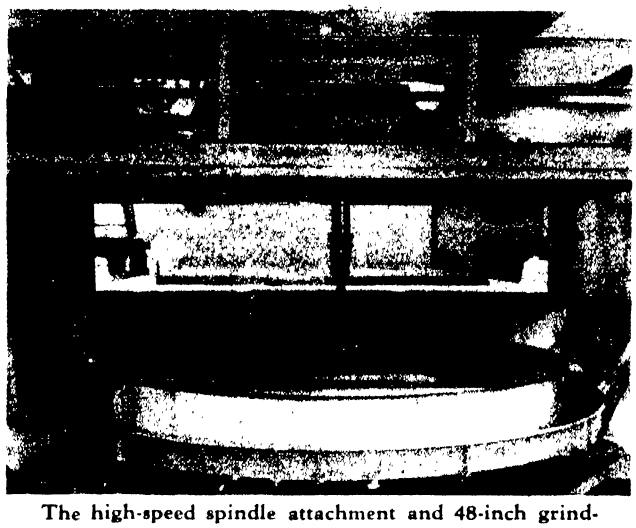
The Mount Wilson Observatory, with its three solar telescopes, its 60-inch reflector, its 100-inch reflector, and several other major instruments on Mount Wilson, aided by its laboratories, computing division, and shops in Pasadena, was at the height of its efficiency, and any solution adopted evidently should not interfere with its future researches. The equipment of the new observatory must therefore be designed so as to supplement, rather than to duplicate, the astronomical and physical instruments and other facilities already available, and a closely co-operative scheme of research must be devised.

The solution was simple, and I prepared a general outline in New York as soon as I found that the desired co-operation between the two institutions could be arranged. Dr. Adams, my successor as director at Mount Wilson, felt that a better site could be found under present conditions for the 200-inch telescope, and a search lasting several years has recently resulted in the selection of Palomar Mountain, in San Diego County. The headquarters of the staff will be in Pasadena, in touch with the California Institute and the Mount Wilson offices and laboratories. An astrophysical laboratory on the grounds of the Institute will provide space for this staff, with such laboratories as will adequately supplement those already available. Near at hand, also on the Institute campus, are the necessary instrument and optical shops. These are also equipped so as to supplement the corresponding shops of the Mount Wilson Observatory, which are still as busy as when they were erected in 1904.

The 200-inch telescope is being designed so as to reach all parts of the heavens seen from our latitude, and will be provided with a variety of auxiliary apparatus. Several types of mounting have been studied, and investigations are still in progress on the final model. A satisfactory type of tube has been designed and rigorously tested in the form of a one tenth scale model, and attention is now centered on the kind of bearings best adapted to support the north end of the (yoke) polar axis. The ratio of focal length to aperture decided upon is $f/3.3$, to permit the faintest and most remote extra-galactic nebulae to be photographed. Thus the principal focal length will be about 55 feet. The great size and stiffness of the tube will permit an observer to be carried in a cartridge-shaped chamber, mounted at the center of the tube at the principal focus. Such a house, affording ample space for the observer, will obstruct only a very small fraction of the total light falling on the 200-inch mirror—no more than a Newtonian mirror would do. Electrical controls within easy reach will permit the observer to move the telescope at will and to observe celestial objects visually or photographically, with spectrographs, or with such instruments as photo-electric cells. The small field of good definition given by an $f/3.3$ mirror will be adequately increased by a correcting lens designed by Dr. Frank E. Ross.



Close-up detail of the high-speed spindle and 48-inch grinding tool



The high-speed spindle attachment and 48-inch grinding tool attached to the 200-inch grinding machine

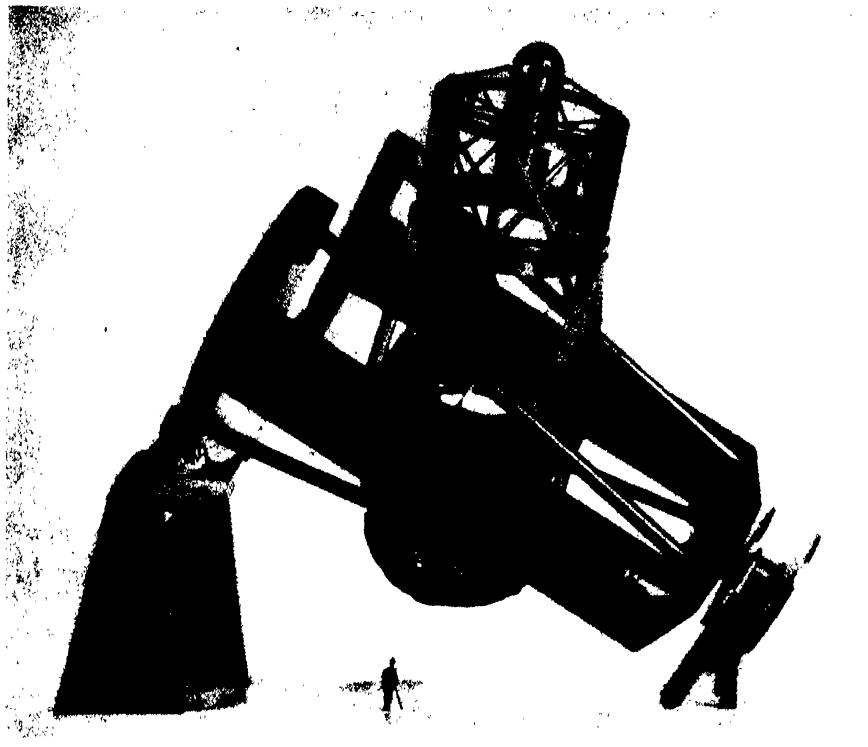
Convex mirrors, to transform the telescope instantly into the Cassegrain or coudé form, will be mounted below the principal focus. One of these, when turned into position by an electric motor, will give a large and well-defined star field below the perforated 200-inch mirror, where direct photographs or spectrograms can be taken.

A special attachment, to be used for the first time with the 200-inch telescope, will be a pair of cradles parallel to the polar axis, hung on opposite sides of the (hollow) declination axis, and so geared that they will hold any instrument in a vertical plane as the polar axis revolves when following a star. Thus a long and powerful spectrograph, or such a delicate device as the most sensitive radiometer, can be employed to excellent advantage on any part of the sky. The converging beam will be sent to the slit or radiometer vane after reflection from a 45 degree plane mirror at the center of the tube and a totally reflecting prism mounted before the slit or vane.

ANOTHER Cassegrain mirror, in conjunction with a plane mirror, will form a star image in a fixed position south of the hollow polar axis. Here it can be analyzed by several powerful spectrographs, mounted on a massive pier in a constant temperature chamber.

An agreement has just been made with the Westinghouse Electric and Manufacturing Company to build the 200-inch telescope mounting at their Philadelphia plant, after its design has been completed at the California Institute.

Because of the low coefficient of expansion of fused silica, a long and seri-



A simple little wooden model, incomplete in several respects, of the mounting for the 200-inch mirror. It is being studied by the Engineering Committee

ous effort was made by the General Electric Company to manufacture large mirror disks of this substance. Dr. Elihu Thomson and his associate, Mr. Ellis, undertook many ingenious experiments, which I have briefly outlined in the *Astrophysical Journal*. In spite of the extreme difficulties encountered, they were successful up to a certain point, but a 200-inch disk proved to be unattainable.

Fortunately we could turn to the unique resources of the Corning Glass Works, where a new form of Pyrex, especially adapted for our needs, was developed by the research staff under the general supervision of Dr. Arthur L. Day. An excellent 120-inch disk, which has been partially ground in our optical shop, was soon produced, and a 200-inch disk is now practically ready for shipment to Pasadena. We are greatly indebted to Dr. Day and the Corning Glass Works and especially to Dr. Hostetter and Dr. McCauley for their skilful work.

A 120-inch grinding machine, and a large one for the 200-inch disk, have been designed and built in our shops. The base of the tube for the 200-inch telescope, built after our designs by the Baldwin Works in Philadelphia and the Babcock and Wilcox plant in Barberton, Ohio, has recently arrived at our optical shop. Approximately 20 feet in diameter and four feet deep, and weighing about 19 tons, it will serve as the turn-table of the 200-inch grinding machine. Within it the 200-inch Pyrex disk will lie on its special support system during the long process of grinding, polishing, figuring, and testing.

In addition to a series of spectrographs, from those giving the very low dispersion serving for radial velocity measures of the extra-galactic nebulae to the large and powerful instruments required for the adequate analysis of the bright stars of our own galaxy, much other auxiliary apparatus is needed. But before speaking of some of this apparatus, two other methods of increasing the efficiency of the 200-inch reflector should be mentioned.

The first of these is the process of aluminizing telescope mirrors, first developed on a large scale by Dr. John Strong of the California Institute. Aluminum mirror surfaces, deposited electrically in a high vacuum, have many advantages over silver. They do not require burnishing, and thus are free from the diffuse light produced on silver by the rouge on the burnishing pad. This is admirably shown by the much greater clearness with which such objects as the companion of Sirius can be seen. Their coefficient of reflection is high over a long range of wavelength, especially in the ultra-violet. This results in an increase of about 50 percent in total reflecting power. Examples of the gain thus obtainable are shown in Wright's photographs of the ultra-violet spectra of planetary nebulae and the large extension of the Ring Nebula in Lyra photographed by Duncan with the 100-inch telescope. Equally important is the fact that they do not tarnish like silver, an advantage best appreciated in the case of large telescopes (the 200-inch mirror, though lightened by its ribbed back, weighs nearly 20 tons).

The small field of sharp definition of telescope mirrors having focal ratios ranging from $f/5$ to $f/3.3$ is well known. An extensive study of this problem, now being made for us by Dr. Ross of the Yerkes Observatory, has greatly improved the efficiency of several large reflectors, and will be still more important in the case of the 200-inch telescope. Dr. Ross has already computed many types of "zero" correcting lenses, which are mounted near the principal focus of the large mirror. Some of them are described in various papers published in the *Astrophysical Journal*.

In order to photograph the spectra of the faintest nebulae, lenses of very short focal length are used in the cameras of special spectrographs. Dr. W. B. Rayton, of the Bausch and Lomb Optical Company, succeeded in designing a lens having an equivalent focus of 32 mm. and a relative aperture of $f/0.59$. This high-speed lens, when used by Mr. Humason with the 100-inch telescope, cut down the exposure time for a twelfth magnitude star from two hours to ten minutes, using two prisms. It is with this lens that the radial velocities of the very remote nebulae have been photographed, leading Dr. Hubble to the determination of the linear relationship between their velocity and distance ("the expansion of the universe").

THE Rayton lens is designed on the type of a 4 mm. microscope objective. Recently Mr. R. J. Bracey, of the British Scientific Instrument Research Association, has designed for us an immersion objective of the extraordinary ratio of $f/0.36$. This lens, made by Beck, should be decidedly faster than the Rayton lens. It gives sharp spectra over an adequate range of wavelength, the focus being on the plane surface of the rear lens of the system, with which the film of the photographic plate is kept in optical contact by a special immersion fluid.

Other auxiliary instruments of great sensitivity and usefulness have been designed for us, including the photo-electric amplifier of Dr. Albert E. Whitford, already applied with great success by Dr. Joel Stebbins on Mount Wilson. With the 100-inch reflector the limiting distance at which a candle could be detected by this amplifier is 3000 miles, assuming no absorption in the atmosphere beyond one mile. Important improvements of the radiometer have been made by Dr. Sinclair Smith, and Dr. Charles G. Abbot, who has already succeeded in measuring the energy curves given by the spectra of several stars at the coudé focus of the 100-inch telescope.

In a more complete account of the above work given in the *Astrophysical Journal* (September 1935) I have added a description of a search for the best

(*Please turn to page* 293)

OUR POINT OF VIEW

Industry and Employment

PERHAPS the most significant point yet brought out in connection with the question of technological unemployment is the fact that, although the population increased 62 percent from 1899 to 1929, the number of gainfully employed persons rose 69 percent. In this particular period, marking the rapid mechanization of American industry, more workers were required, in proportion to population, than ever before. During that period, the national income rose from a mean average per worker of 547 dollars in 1899 to 1719 dollars in 1929, the income per worker rising 215 percent in dollars, or 48 percent in purchasing power. Thus the question of technological unemployment becomes merely an academic one. It is all a matter of viewpoint. Each new machine, or set of machines for a particular process, does necessitate a temporary period of adjustment, but by the long view is seen to add new employment.

In a new book "Machinery, Unemployment, and Purchasing Power," by the National Industrial Conference Board, the economics of the machine are once more elucidated in a fact-finding study that withstands a most searching analysis. To the figures quoted above, others equally as pertinent may be added. There is, for example, the unquestioned fact that in the 50 years ending in 1929, 18 new industries came into being and accounted for an 18 percent increase in total employment. Manufacturing as a whole employed 29 percent of the working population as against 21 percent 50 years earlier. No more definite proof that machines make jobs could be adduced.

The status of the trade, transportation, and service industries has also shown vast improvement. These three absorbed only 10 percent of the workers in 1879 but 29 percent in 1929. Domestic help jumped from 10 to 13 percent. Yet machines innumerable have been developed to "compete with" human labor in all these fields.

As a Parthian shot, the Board's study dispels the delusion that present unemployment is permanent, a point on which there is a continual babble of uninformed argument. Industrial production in June, 1935, stood at 71 percent of the 1929 average, yet employment was 76 percent.

Despite facts and figures, however, the country will probably continue to be treated to the spectacle of spell-binders urging audiences to smash machines or perpetrate some other equally foolish act. "Because of the machine" they have already urged reduction of working hours to a ridiculous point. What would have been the status of American industry today—indeed, of the American worker—had such misguided zealots fought their fight and had their way at the birth of the now enormous electrical industry just 50 years ago!

Japanese Example

COLDS are so often of an epidemic nature, and are so common to all seasons of the year, that it would be greatly to the advantage of our country to adopt a certain Japanese custom which has been recommended by Dr. John E. Loveland, a Middletown, Connecticut, physician.

The Japanese, instead of shaking hands, bow deeply and often several times when they meet socially. In a room full of Japanese this habit shows itself to be a gracious, cordial address, fully as friendly as our hand shake.

We may well imitate the Japanese in their forms of politeness, for they have a reputation of being among the most polite people in the world.

In our country a person with a cold contaminates his hands by his handkerchief and then, in shaking hands, inoculates other hands. If a public enemy wanted to start an epidemic of colds in a city, he could accomplish his purpose effectively by hiring a person with a cold to go about shaking hands with as many persons as possible.

In Copenhagen, in a large laboratory, the staff and guests are instructed not to shake hands.

If we could do away with this uncleanly and infectious habit in our country we would probably prevent much discomfort and loss of time from colds, and by preventing epidemics we would lessen loss of life among infants and old people. Pneumonia usually is ushered in by a cold.

The embarrassment of refusing a handshake can be avoided by substituting a more kindly tone of voice and more of a smile and bow.

If a group of our leading people such as our college professors, judges, and doctors—especially the doctors—would start the hygienic bow agoing they would be public benefactors.

Placards could be used in places of congregation, requesting the omission of hand infection. With very little effort we could break up the unnecessary passing around of the bad that is temporarily in us. What misguided cordiality it is to distribute disease under the disguise of a friendly hand grasp. Many of us realize this fact but feel that we must continue to follow the conventional method of greeting because it is conventional. But it is a conventionality which arose before the age of science, and in our era it is essentially unscientific.

American Practice

SHORTLY after the war, at a time when America had already outstripped the world in paved highway construction, we read with amusement one British writer's reason for the high power of American cars. Their high power, in contrast to contemporary European practice of building low power cars, was necessary, said the commentator, to negotiate roads of our wild and undeveloped hinterland! Europeans are now beginning to understand the real reason, and are rapidly adopting American practice. The change is coming about because of the new high-speed highways being built on the Continent.

In Germany and Italy, particularly, have great highway construction programs been carried out; and in our last issue was published a short item on Europe's Highway No. 1, which is eventually to link London with India and South Africa. On highways such as this, where there is no speed limit, old-style engines burned themselves out and fell apart after an hour or so of hard running. And there is no question as to hard running, for the German highways have two lanes, each to accommodate four cars abreast; and both these and the Italian Autostrada are toll roads having no grade crossings. The result is that the old type European engines are being re-designed along American lines, with particular attention to bearing pressures, methods of lubrication, and safety factors. Designing engineers everywhere are receptive to American ideas. They seem especially interested in the use of aluminum cylinders and in latest American combustion chamber design.

As the user of more cars than all the rest of the world combined, America has been the proving ground of highway and automobile practice. It is to be hoped that other nations, in drawing on our experience, will also observe and heed the warning of our vast number of automobile accidents. They can draw many lessons therefrom, if they will.

Do Hatchery

SOME people think that hatchery trout are as far removed from a real trout as a Caspar Milquetoast is from Mussolini. They deem them nothing but caricatures of the fish that once filled our clean, cold streams and lakes. They judge them helpless, unfit, over-fat, tasteless, pampered degenerates raised at great expense and turned loose to perish unless some deluded angler catches them first as a substitute for real fish.

If these contentions are accurate, then the fishermen of our land are in a bad way indeed, for no other way is left to provide fishing at home except to release these same hatchery-reared trout.

It has been said time and time again that trout are just incidental to the outing; that the real joy of fishing lies in the blue sky overhead, in the bits of bird song, and in the play of sunlight and shadow on the riffles. All very nice—*but* show us a man who does not feel ever so much more appreciative and soothed if the trout are there and rising and if his creel sags a little heavier as the hours pass!

Full creels today, however, would indeed be rare if it were not for the restocking of trout waters by states, government, and sportsmen's clubs everywhere. Each year there is a cry for more and larger fish and each year sees our streams whipped harder. It is no wonder that, with the demand for an ever-increasing output, our fish-rearing establishments have not had much time to see if they were turning out the best sort of trout possible. Trout rearing at its best is a gamble and all too often the fish culturist is too busy being thankful for any kind of output to do much worrying about any shocking differences between the appearance and behavior of his pets and the wild fish they are intended to replace.

Fortunately, there has been so much learned about the feeding and care of trout that it is no longer necessary to turn out ludicrous imitations of the genuine article. It is possible to raise trout at hatcheries in no way inferior as to shape, color, and vigor to the typical wild fish. I do not say that this is being done everywhere, but it is possible where environment and diet are correct.

Such an improvement in hatchery trout is the result of years of experimenting not only by the United States Bureau of Fisheries but by other agencies. For example, the Bureau of Fisheries in 1925 turned over a trout hatchery at Pittsford, Vermont, to be devoted entirely to research in trout culture. The business of this hatchery is to make the fishermen of the country more agreeable people to live with by finding means to provide them with bigger and better trout at less expense. Thus, studies in the diagnosis and control of fish diseases, elaborate feeding tests, selected breeding work, and a program of stream improvement and related studies of trout stream production have all played a part in the task of restoring our overworked trout waters to a semblance of their former status.

THE starting food usually used at the Pittsford hatchery is finely ground beef heart or liver. Heart, lungs, liver, and spleen of swine, sheep, or cattle are time-honored hatchery foods. Fish is also used extensively in some situations. At Pittsford various dried products, when mixed with finely ground liver, make the trout grow faster. Dried foods successfully used have been fish meal, meat meal, dried buttermilk, clam-head meal and others. Salmon egg meal makes the fish grow faster and gives better color than the others. The food bill is always the chief item on the list of hatchery expenditures. Dried foods must never be used alone; some fresh meat is required to keep the fish in condition.

The present article, however, considers only the results of some experiments designed to find out whether the trout produced in the course of the work would be worth anything as game fish.

The first test involved 100 marked brook trout liberated in August of their second summer in an excellent trout stream adjoining the hatchery. The primary object of the experiment was to see if the fish were capable of finding their own food soon after planting or if there would be a gradual period of adjustment to a new environment. Their behavior as sporting fish was, of course, of equal importance.

It was planned to give the fish approximately 24 hours' liberty and then to commence taking a daily sample of ten fish with rod and reel until all, or as many as possible, of the fish were recaptured.

On the day following liberation the first assault was made on the planted trout. As I approached the brook I admit having felt a bit excited, for I was intensely interested in seeing whether those trout would respond to flies in true game-fish fashion. There was not long to wait! In the fast current of the first liberation pool a trout hit the gray hackle with force and accuracy, and from the rise until he twisted on the shore he did his best to undo his fatal mistake. An angler who found fault with that battle for freedom would be a hard person to please. As I went about the business of preserving the stomach in a bottle of formalin for future study, and setting down the data as to the place of capture and so on, I found myself wondering if this well-behaved fish was the exception, but before the daily sample had been taken all doubts had vanished. Those hatchery fish needed no

Weighing food to be fed to trout at the Pittsford, Vermont, hatchery

Trout 'Go Wild?'

Restocking is the Trout Fisherman's Only Hope for the Future . . . Proper Methods . . . Results of Hatchery Experiments . . . "It Can Be Done"

By RUSSELL F. LORD
In charge, U. S Experimental Trout Hatchery, Pittsford, Vt

one to apologize for them in any respect.

The brook itself was low and clear and it was soon found that as much care was necessary in approaching pools as in any ordinary fishing. A sudden movement on the shore would send the fish darting for cover as if they had spent all their lives in avoiding mysterious shadows on the edge of their watery world. When they decided to take a fly they struck hard and acted as trout should act. Due to a diet designed to bring out the colors, they were as brilliantly marked as the ordinary wild fish. And, incidentally, the flavor of the specimens was not to be adversely criticized!

Not only were these fish proving to be on the alert for food, but they were actively competing with the trout already present in the stream. For example: On one cast the angler hooked and landed not one fish, but two! A wild rainbow and one of the newly-planted brook trout had both struck the moving flies and of the two fish the brook trout was more firmly hooked. Rainbow trout have a habit of getting under way like lightning once they decide on something tempting, but the hatchery-reared brook trout was equally alert.

THE stomach of the brook trout showed an interesting assortment of food. The posterior end still contained remains of the last hatchery meal, while the anterior end contained 13 freshly taken caddis worms and a few mayfly nymphs. This did not look as if the pampered hand-raised trout had been very much handicapped by its former confinement.

Fishing continued until 82 of the 100 brook trout were recaptured and every moment of it was real fishing. The trout responded when it pleased them to do so and before the final score could be tallied the anglers were forced to resort to a variety of lures. The fish definitely did not "come easy."

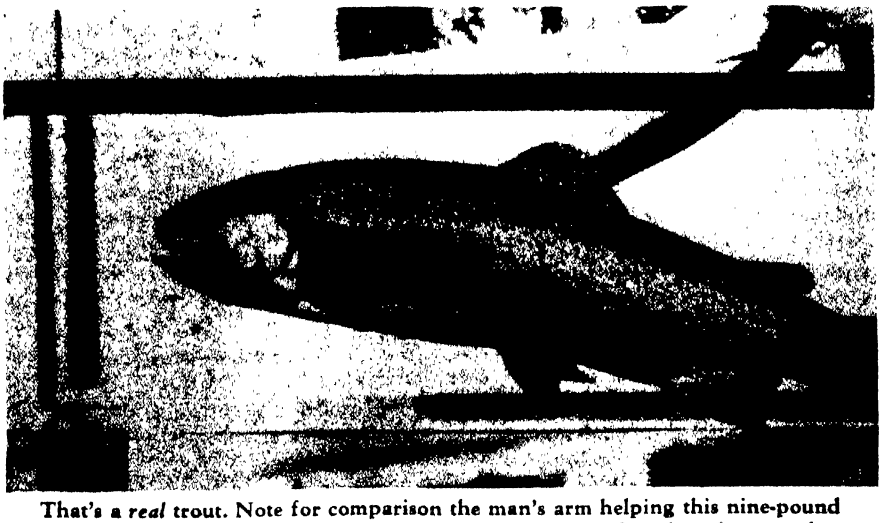
Every stomach was preserved and contents analyzed. If it is assumed that hatchery trout must gradually learn to forage for themselves because of their new environment, we might expect to find a steadily-increasing number of food organisms in the stomachs as time passed. Such was not the case. Nothing resembling a daily increase in the amount of food was observed. The only conclusion possible, therefore, is that hatchery environment had little deleterious effect on the ability of the fish to forage for themselves on short notice. In fact, the average number of insects per stomach was very close to that found by another investigator who examined the stomachs of a large sample of wild trout from New York State waters.

It is not surprising that hatchery fish can take up the business of foraging. One has only to observe a pond of fish during the summer when the midges are active or a hatch of mayflies is on in a nearby stream. I have seen fish jumping in the Pittsford ponds so steadily that dozens of them were in the air at once, and they kept it up as long as the insects were active. At other times the fish in the ponds have been observed working over the bottom gravel, picking it up in their mouths and ejecting it with force. This winnowing process allowed the heavier gravel to sink while the midge larvæ, which represented the gold of the mining activities, were snapped up before they settled to the bottom. Often too, when fingerlings are being transferred to outdoor pools, the first pailful of transplanted fish can be seen reveling in their freedom and jumping for low-flying midges before the second pailful of young fish has been brought from the hatchery. From my observations it seems that a trout on being liberated is as pleased as a small boy quietly raiding the ice-cream freezer on a school picnic. Everything is his; lots more of his favorite food and nobody to curtail any little whim!

THE general conclusion is that the anglers of our country need no longer feel too downcast over the passing of typically wild trout. Hatcheries can, if they follow the right methods, rear trout capable of taking care of themselves on being planted and that will be pleasing to the anglers as game fish. This can not be done, however, by holding fish in an unsuitable environment and feeding them the first thing that comes handy. Not all hatchery-reared fish can be expected to meet the requirements. The hatchery environment should approach as closely as possible the waters to be stocked. Over-fed trout reared in relatively warm, crowded pools can not any more be expected to make good in a cold, swift stream than a soft city man can be expected to duplicate the feats of his northwood's guide. In short, our trout fishing near home is entirely up to the hatcheries, and it is up to the hatcheries to see to it that the fish put out are something worth the expense of rearing and the effort of catching. The bright spot is . . . *it can be done.*

●

Sportsmen can do much to promote better fishing in their localities by urging scientific methods in their own hatcheries. More emphasis should be placed on better fish than on quantity production.—The Editor.



That's a *real* trout. Note for comparison the man's arm helping this nine-pound hatchery-reared mamma rainbow trout to look pretty for the photographer

Cut Weight—Cut Cost

Welding's Rapidly Growing Importance . . . Used for Production, Patching, Repairs . . . Saves Weight and Thus Modifies Design Practice

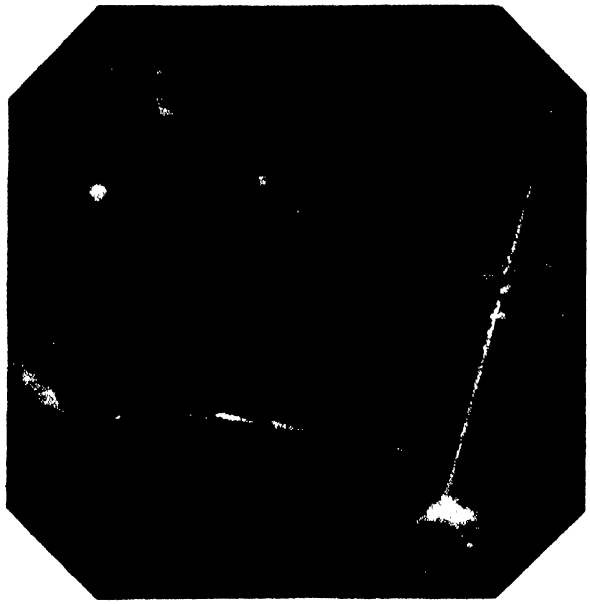
By PHILIP H. SMITH

WELDING is revolutionizing production technique. Within the past half dozen years it has graduated from primarily a tool of repair to a foremost tool of production.

In almost every enterprise which involves joining of metal, welding has been introduced because it permits faster, cheaper, and better work, and produces a stronger and lighter product.

It is welding to which we owe the low-priced automobile without squeaks and rattles, the streamlined train, the railroad track without the clickety-click at rail joints which makes for passenger discomfort and maintenance expense, and airplanes which fly to the Orient on schedule.

Welding can be made to serve several purposes, although it is strictly a process for joining metals. It can be used for fabrication, for repair of broken or worn parts, and for hard-surfacing parts in new equipment or machinery which have become worn in use. A major, indirect achievement is reduction of product weight. Welding strikes at the weight problem from several angles and in so doing it creates new standards. It does away with bolts, rivets, and re-inforcing sections in joining metal pieces. Elimination of rivet holes makes for greater strength, hence smaller sections can be used. Welding also makes possible the use of high strength steels in place of castings. This means the elimination of useless re-inforcing metal as well as a lightening of the product itself by virtue of using a stronger material.



Flame welding, as an efficient mender-of-metals, quickly repairs broken machine parts of all kinds

IF you search through books to find out why welding has suddenly become so important, you will get little satisfaction. Welding is not a new art. Gas welding goes back nearly 40 years; resistance welding has been known for 50 years; the first patent on the carbon arc was issued about 50 years ago, and one on the metallic arc followed immediately. Current achievements cannot be explained by a simple recitation of discoveries, because they really stem from a series of minor developments.

Welding is a primary tool of industry today because a few pioneering souls kept everlastingly pushing it. Scientific American prophesied a great future for it some 15 years ago—despite the terrific fight that was being waged against it—but it takes a long time to overcome industry's resistance to the new. It requires pressure and in this case the "push-over" was given by the depression. Manufacturers seeking greater economies in fabrication found welding ready to be used and coincidental developments made it much more practical and dependable than ever before.

Welding metallurgy, practice, and equipment have all been improved. It has been learned, for example, that metals can be made more weldable by adding small amounts of other metals to the base metal, or to the electrode, or to both. A case in point is the addition of columbium or titanium to stainless steel to reduce the formation of carbides and to give welds which will not corrode. Copper, long regarded as difficult to weld electrically, is now being handled very easily by the "long-arc" process. Advances in equipment cover an even wider range. Multi-flame torches have reduced costs and increased speeds in oxy-acetylene welding, while electric welding machines have been made largely automatic in operation so that high speeds can be maintained and good welds produced with a minimum of worker fatigue.

One of the most ingenious equipment developments in arc welding is the coated electrode. It is well known that certain metals oxidize readily at high temperatures, and the formation of oxides is apt to result in imperfect welds. To get around this risk, the electrode is covered with a flux coating which fuses along with the wire. The flux protects the metal while going through the arc and covers the deposited metal to exclude practically all oxides and nitrides while the metal is solidifying. Such coatings contain a substance to help maintain a steady arc, the stabilizer usually being titanium dioxide.

Today a manufacturer has at his disposal a number of different welding processes to meet the varied requirements of material and design. These types are: gas, electric arc, flash, resistance, atomic hydrogen, and thermit; a brief description of them will aid in a later portrayal of achievement.

GAS welding burns acetylene and oxygen to supply the necessary heat for fusion. Recently it was discovered that an excess acetylene or carburizing flame has a marked advantage in the welding of plain carbon steels because it increases speed and efficiency. Its paramount use is for welding overland pipe lines and industrial pipe.

Arc welding employs either a carbon or metallic electrode. When the carbon electrode is used, additional metal is supplied by a filler rod as in acetylene welding; the metallic electrode itself melts down in the heat of the arc to supply the weld metal. Metallic electrodes differ in composition depending upon the kind of metal to be welded, and the various metallic ingredients are introduced to the deposit either from the rod or the coating.

Flash welding likewise employs an arc. Pieces to be welded are placed close together and then separated to create an arc. When sufficiently heated, the pieces are brought together under pressure.

Resistance welding covers all types where resistance to the passage of an electric current generates localized heat. Under this classification come butt, spot, and projection welding. Butt welds are made by clamping work in close contact and letting the current flow until the joint is heated. Union is then made by applying a forging pressure. Spot welding is performed by placing two sheets of metal in contact between tapered electrodes and permitting a low voltage, high amperage current to pass through the circuit for a brief period to fuse the metal at the electrode points.

A PROJECTION weld is a modified spot weld. Here projections or buttons are raised on the sheet or plate at the points to be welded. When a current passes, the projections themselves act as electrodes and a series of welds are thus made in one operation.

Spot welding has two other forms which are important. One is seam or stitch welding; the other, shot welding. Seam welds resemble stitches in appearance because the weld is formed by a series of overlapping spots. The electrodes are fitted with rollers and the work is fed between them to effect a series of intermittent welds. Shot welding, sometimes called electro-percussion welding, calls for the passage of a low voltage, high amperage current between copper electrodes and through the plates to be welded, the electrodes pressing against the outer sides of the plates. This achieves an intense, quick heat which does not penetrate to the outer faces of the metal where it would reduce the non-corrosive properties. Momentary high surges of power are obtained without high kilowatt demand by means of a condenser or an inductive winding which constitutes a potential reservoir. This reservoir fills and overflows with each shot.

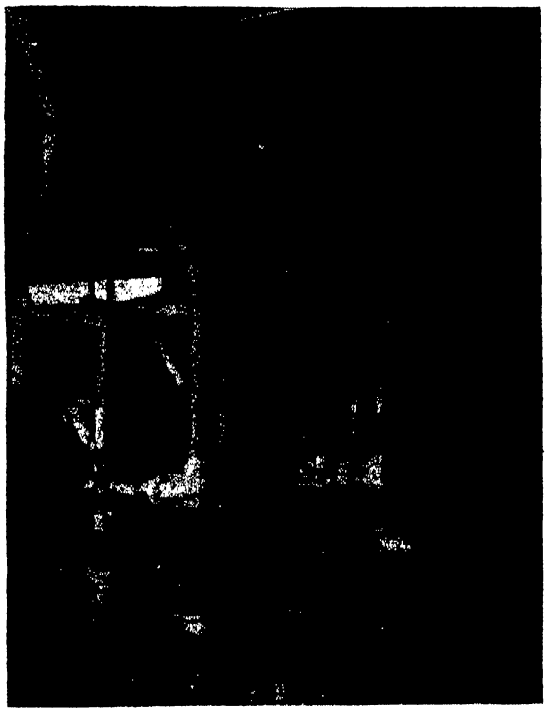
Atomic hydrogen welding is relatively new. In effect, a stream of hydrogen is passed through an arc between tungsten electrodes. The molecular hydrogen breaks down into the atomic state with absorption of great heat. Upon leaving the influence of the arc, the hydrogen reverts to the molecular state, giving up its absorbed heat to the metal which it fuses. The hydrogen creates more heat while burning and also excludes air from contact with the weld.

Thermit welding utilizes the reaction between powdered aluminum and iron oxide at high temperature. A charge of these materials is ignited in a crucible and when the temperature rises above 2800 degrees Fahrenheit, the aluminum unites with the oxygen of the iron oxide to set free the iron at a high temperature. At this point the molten metal is allowed to flow around the joint to be welded, to melt it and then to solidify to form a homogeneous mass.

Industries which have to do with transportation afford the most striking examples of the use of these processes in fabrication. The automobile industry sets the pace. This can be attributed in part to the proverbial willingness of the automobile manufacturer to adopt anything which will bring about production economies, and in part to the fact that producers of moving mechanisms are most conscious of the importance of weight reduction.

A vast amount of development work had to precede the application of electric welding to mass production. Means had to be found to repeat the welding cycle automatically and control had to be established over pressures, heat, and timing. Welding had to be made a precision operation before it could be fully accepted. Now with that goal attained, electric welding has become a genuine tool of mass production.

Resistance welding is well suited for automobile manufacture because it affords the means for uniting forgings and stampings into strong, light, integral parts at a speed unequaled by most other processes. One of our lowest priced cars boasts more than 3200 welds, and to put them in requires more than 600 welding machines and over 1000 welding torches. Gas, flash, butt, spot, seam, and electric-arc welding are employed. The fuel tank, for example, is made in halves and united by seam welding. The seam runs 102 inches and is finished in 90 seconds. Rear radius rod brackets are welded to the axle housing at the rate of 55 inches per minute, while a vast number of sub-assemblies undergo similar speed treatment.



Arc welded piping and valves

Arc welding, too, is an important tool for repairs. Here a broken gear is being given an arc-welded filling of new metal in which new gear teeth will be cut

To list all welding operations would be tantamount to describing all assembly; enough to say that the car body emerges as a single metal unit without bolt or screw to hold it together—and later to let it fall apart. The saving in time, material, and weight conspires to produce a vehicle that is better and cheaper than its counterpart of a few years ago.

The saving of weight made possible by welding is of paramount importance in aircraft construction. High-strength alloy steels, welded together in lasting union, spell low weight, high performance, and maximum safety. The *China*

Clipper, which has mastered the Pacific, reveals exceptional use of welding as the following item will testify. The engine mounting comprises two circular brackets made of 18- and 12-gage chrome-molybdenum tubing, welded to form. It weighs but 74 pounds yet it supports an 800 horsepower engine weighing 2380 pounds, and takes the vibration without a whimper.

The railroads are a little behind the procession but are coming fast. Here again weight reduction is vital to operating efficiency. The railroads recognize that their come-back depends largely upon a modernization of equipment, leading to higher train speeds and increases in pay loads. Their steps to this end involve the use of high-strength alloy steels coupled with welding.

THE Burlington *Zephyr* is an example of welding progress. The bumper, engine bed, and bolster are formed from high-tensile-strength steel alloy plates arc-welded together. The Diesel engine-block is built up from welded steel plates. The body proper is constructed entirely of cold rolled stainless steel, shot welded. Stainless steel, substituted for ordinary steel, achieves an ultimate strength of 150,000 pounds per square inch as contrasted to 45,000. No weakening of the structure is occasioned by rivet holes, nor are there any rivet heads to offer resistance to the wind.

Having seen motor truck bodies lightened, the railroads have applied the idea to freight cars, finding that welded alloy steels permit a saving of 25 percent in weight of hopper cars. This new construction gains a payload increase of 10,000 pounds per car and a corresponding reduction in dead weight to be hauled back empty.

Railroads have made shop use of welding for many years. Locomotive frames, driving-wheel spokes and centers, rocker shafts, cross heads, guide yokes, and a great number of other parts are kept in repair with welding. A new technique is to build up worn hub liners by simply depositing the right kind of bearing metal, saving time and cost of disassembly and replacement.

Rail maintenance is a big item in operating costs and is bound to increase under the hammering of higher speed trains. It is claimed that the railroads of the country repair 500,000 battered rail joints with oxy-acetylene welding every year and 400,000 with the electric arc. Now comes a scheme which promises to reduce this upkeep expense substantially.

The new idea calls for welding rail ends together to do away with the majority of joints. What we learned in school about the need for expansion joints between rails was all a mistake. Rails have been joined satisfactorily in lengths as great as 2600 feet, though the practice abroad where the method has been well tried out, is to limit lengths to about 400 feet. There is no warping or buckling of the rail and wear and tear is cut sharply. Some authorities say that maintenance can be reduced as much as 65 percent, and figuring rail upkeep at 300 dollars per mile per year, here is a potential saving of large proportions.

Reducing the weight of moving mechanisms is not confined to transportation. In the electrical industry a beginning has been made in replacing castings with fabricated structural steel, arc-welded, to save anywhere from 25 to 50 percent in weight. A typical example is a rotor for a synchronous motor, arc-welded from steel plates and rolled H-sections. A similar trend is observed in other industries where intricate shapes are cut with oxy-acetylene flame and then welded.

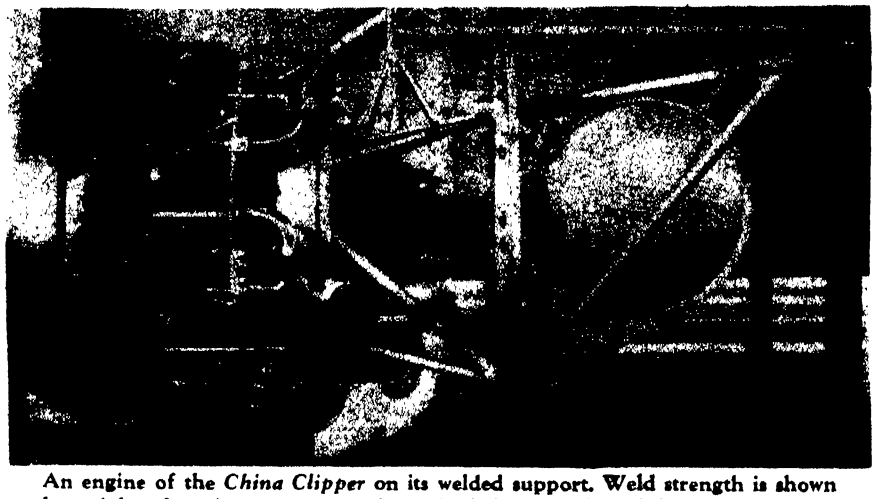
Welding has been pioneering in building construction for many years, but only now are real results appearing. The possibilities are very clearly revealed by the following comparison between welded and riveted types of construction:

If we take a standard riveted beam, 15 feet long, weighing 798 pounds, with an elastic limit of 55,000 pounds per square inch and ultimate load of 68,900 pounds, and switch to welding, the weight can be reduced to 785 pounds, yield point raised to 65,000 pounds and the ultimate load lifted to 77,200 pounds. If the beam is redesigned to make the most of welded construction, the weight can be reduced to 656 pounds, with the yield point holding at 65,000 and the ultimate load rising to 78,000 pounds. Generally speaking, welded construction can save from 15 to 30 percent in weight over the riveted form.

Probably the largest welded structure at the moment is the Sterling Memorial Library at Yale which soars 18 stories into the air. Under construction in Illi-

Welding finds more and more uses in many phases of building operations and in engineering. Here the water main to a building is being joined permanently by the electric arc

Design of some of the newer, pre-fabricated houses is predicated on the use of welding of studs, braces, and the like. The design shown here is all steel and welded throughout



An engine of the *China Clipper* on its welded support. Weld strength is shown by weight of engine: 2380 pounds, and of the welded steel frame: 74 pounds

nois is a modern factory into which will go 2000 tons of welded structural steel and about 50,000 feet of weld. In residential building, notable work has been done in framing and now comes a welded house without frame.

This arc-welded structure, just announced, is made up of sheet steel panels: two sheets four by nine feet to a panel, with insulating material between. The panels are simply welded together and then sprayed with paint and white silica sand to give a plaster or stucco effect. Not a single nail nor a piece of wood is used. Such construction reduces the amount of material required, permits factory production of insulated panels, and speeds up erection on the site.

The qualities which make welding suitable for uniting structural steel are those which recommend it for repair and construction of bridges. Pressed to find ways of maintaining bridges in the face of lower appropriations, one county highway department has adopted welding for all repairs of parts that have failed or suffered from corrosion. It has even gone so far as to salvage old bridges and re-form them to make new ones.

Unique "amphibian" landing truck for the *China Clipper*. Made of welded chrome-molybdenum steel tubing, this cradle is used to haul the giant plane ashore

An arc-welded butt joint and a welded steel roller support for a 14-inch steam pipe line

Welding does a production job. The strong, welded, airplane control socket shown below was made up of 18 pieces

Among the many other uses of welding which have come to the fore in recent years, there should be mentioned the joining of pipe to make miles and miles of unbroken overland lines, and the installation of domestic and industrial piping of all types. The bulk of this work is being done with oxy-acetylene welding. Household refrigerators are full of welds today. Home and office furniture is being made of welded steel and even kitchen utensils are being fabricated with a welding process. Pressure vessels for industry and tanks for the storage and shipment of milk and chemicals are being fabricated from non-corrosive metals; this field has as yet hardly been touched.

In the field of industrial work, bronze welding is gaining rapidly as a means of repair. Practically all commercial metals can be so treated, the practice being one of depositing bronze from a welding rod, using the oxy-acetylene flame to melt the rod and to heat the base metal. Although the base metal is not melted and there is no fusion with the bronze, extraordinarily strong welds can be made.

Closely allied to this process is the bronze-surfacing of metal parts to improve their wearing qualities. Bronze-surfacing can be used on new wearing parts or to build up worn ones. When parts are subject to extreme abrasion as is common in mining, dredging, and drilling equipment, hard-surfacing can be effected by use of an alloy material. There are several such alloys now available; one is a chromium-manganese-iron; another is cobalt-chromium-tungsten; and the most recent to appear on the market is cast tungsten carbide, a material with near-diamond hardness. The carbide is crushed and screened and placed in a steel tube to form a welding rod. When the tube is melted by an oxy-acetylene flame the tungsten carbide is distributed evenly over the wearing surface and bonded by the steel from the tube. Hard-surfacing is in its infancy and destined to grow because of the dollar-and-cents saving.

With brass, bronze, aluminum, copper, and alloy steels now being welded successfully on a production basis, the manufacturer who would utilize the best that research has made available can no longer ignore welding as a tool of fabrication. The product may be tanks for industry, machine tools, or agricultural implements—it doesn't matter what—there is a strong probability that welding has something to offer.

MANY welding processes are now so automatic that operation is no more unpredictable than it is with the modern machine tool. This is true despite the fact that there remains a great deal of art in the technique of welding. Operation can be controlled and quality can be maintained, even at high rates of speed. Indeed, it is this high degree of control which makes speed and quality mutually inclusive.

The field for welding has only begun to open up, even though its basic principles *were* known a half century ago. We are now poised on the threshold of a new era. Welding, coupled with recent metallurgical developments, is about to transform the industrial world. And when its contribution is finally chalked up, perhaps the outstanding items will be the rejuvenation of the railroads and the unscrambling of the home building problem.

Photographs courtesy Climax Molybdenum Co., Hobart Bros., General Electric Co., and The Linde Air Products Co.

A Catastrophe That Did

Why the Billion-Ton Minor Planet which Recently Passed Closer to the Earth than Anything Ever Known to Astronomers did not Strike it . . . The Earth is Safe for a Long Time to Come

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society

WITHIN the past month a discovery of unusual interest has been announced. On the 12th of February, Delporte, an assiduous and successful observer of asteroids, reported from the Belgian National Observatory at Uccle, near Brussels, the discovery of a faint object, of the 13th magnitude, in the constellation Leo, which showed a most unusual motion—south-westward at the rate of very nearly two degrees per day, which is eight or ten times the average rate for an asteroid near opposition.

Later observations—cabled to this country in answer to a request from Harvard—permitted the computation of a preliminary orbit, which showed that this body was receding from the earth, and rapidly growing fainter, and was in danger of getting lost. Fortunately, the weather cleared late that night, and a photograph showing the object was secured at the Harvard station at Oak Ridge by Whipple and Cunningham—the latter the computer of the orbit, who must have felt well repaid for the high-pressure work of calculation by this happy result. Since then, more observations have been secured at Harvard, Yerkes, and Lick—and doubtless also in Europe, though the mails which would bring them here have not yet arrived—and several computers have described orbits which agree well enough to make it evident that the newly-discovered body is moving in one of the most remarkable orbits known to astronomers thus far.

Figure 1, which is based on calculations by Mr. Herget and Miss Davis at Berkeley (the latest now at hand), shows the situation clearly. At perihelion, the orbit comes within 41 million miles of the sun—less than Mercury's greatest distance: at aphelion, the distance is slightly more than 300 million miles—more than halfway from the earth to Jupiter. The orbital eccentricity is 0.763, and the orbit resembles that of a comet, rather than a planet.

For this reason, the body has so far been called by the non-committal name of the "Delporte object." Van Biesbroeck, however, observing with the 40-inch Yerkes refractor on February 22, found that it appeared perfectly stellar, with no trace of hazy surrounding light—which is sufficient reason for classifying it as an asteroid. No other of the more than 1300 minor planets has so eccentric an orbit: but Hidalgo, discovered in 1920, runs it fairly close, with an eccentricity of 0.65.

Along with this high eccentricity goes a very low inclination, 1°25′. In consequence, the orbit passes very close to those of Venus, the earth, and Mars. In our diagram, the earth's orbit is supposed to be exactly on the plane of the paper. The other orbits come up through it at the points marked by cross-lines, and drop below again at the dotted cross-lines shown on the opposite sides.

A photograph of the constellation of Orion, taken by C. A. and H. A. Lower of San Diego, California, with a Schmidt telescope of the type described by Professor Russell in the number for July 1935. The telescope or camera has an aperture of 10 inches and a focal ratio of *f*/1 and its notable feature is the fact that, unlike telescopes with ordinary paraboloidal mirrors, it has a very wide undistorted field—up to 12 degrees in diameter. Built by H. A. Lower, such a telescope consists of a spherical mirror and at the upper end of the tube, a thin, irregularly curved, plano-concave lens whose function is to counterbalance the spherical aberration of the primary mirror. On examining the half-tone with a lens it is evident that various pairs of stars on the original have linked themselves together in the reproduction, but on the original negative the stars are everywhere tiny round sharp dots

The closest approach to the earth's orbit is at the point marked *A*, where the planet's orbit lies above the earth's, but by only 1/60 of the distance between either one and the sun—that is, no more than 1,500,000 miles.

This is the closest possible approach between the earth and the new asteroid—and it actually happened, very nearly if not exactly, on February 7th. When the planet was discovered, it was about eight million miles from us, and receding at the rate of a million and a quarter miles per day. By the end of February, it was 28 million miles away, and at the end of March it will be 80 million miles from the earth and twice as far from the sun.

ON the other side of the sun, as the planet comes in, its approach to the earth's orbit is not so close—about 2,200,000 miles—but still very much nearer than any other planet ever comes.

The approach to Venus' orbit, at the point marked *B*, is still closer—about 1,000,000 miles. The least distance from Mars is at *C*, and is slightly less.

A hypothetical inhabitant of this planet would therefore have remarkable opportunities of observing these three larger neighbors. The earth, at the recent close conjunction, would have appeared to him three fifths as large as the moon does to us—a conspicuous disk to eyes such as ours—nearly at the full phase as it approached, a half-moon when largest, changing rapidly into a crescent and shrinking as it receded. Venus, at a similar favorable opportunity, would look as big as the moon does to us, and Mars more than half as big. This little world would be a fine station for planetary observers!

They would have to be long-lived, though, to hope for many good chances. The planet's period is calculated as 2.55 years, or about 930 days. If it finds

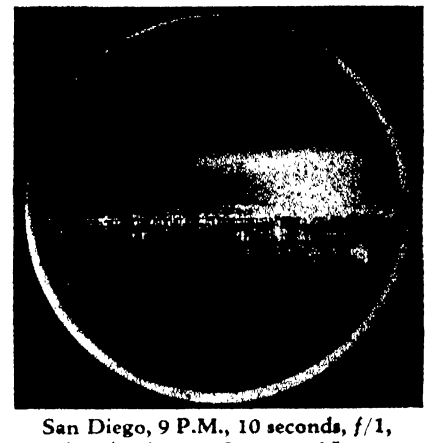
NOT HAPPEN

the earth close by at a given return to the conjunction-point, next time the planet will be right away on the opposite side of its orbit. To get a really favorable approach, the earth, which moves 1,600,000 miles a day along its orbit, must return to this point within less than a day of the time when the planet reaches the corresponding place upon its path.

Among conjunctions, taken at random, therefore, not one in 500 will be as favorable as that which has just passed unobserved, and the average interval between them will be more than 1000 years. Venus moves faster and close approaches should therefore be somewhat rarer, while for Mars they may be a little more frequent.

PASSING from fancy to fact, we notice, conversely, that it may be as long before we dwellers upon earth may have another equally good chance to see the new planet. It must be a very small one. From the rough estimates of its brightness which are so far available, it appears that, if its reflecting power is similar to that of Mars or the moon, it is from half to three-quarters of a mile in diameter—a mere "mountain broke loose." Next year, when it is again in opposition, it will be near aphelion and it would appear like a star of the 22nd magnitude—beyond the power of even the greatest telescopes to reveal, even if we knew precisely when to look for it. When near perihelion it would, like Mercury, have a small angular distance from the sun, and would be very difficult to photograph. The only chance of finding it again would seem to be when it once more approaches one of the two favorable points at nearly the same time as the earth does. Unless it can be followed with large telescopes and very carefully observed, then it is lost in the distance even for them. It will not be possible to determine the period accurately enough to justify predictions over a long interval; and it may be a long time before it is observed again.

This strange little body sets one speculating. How has it been able to follow its orbit for millions of years without colliding with one of the planets which it so narrowly misses? In the short run, this offers no difficulty—a million miles is really fairly wide of even a planetary target. But in the long run, the inclination and eccentricity of its orbit will slowly change, as will those of the larger planets, owing to their mutual perturbations. A change of $1\frac{1}{2}°$ in the relative inclination of its orbit to the earth's would bring a chance of actual collision. We do not know, in default of laborious computations, how fast the planet's orbit plane will shift, but to change the plane of the ecliptic by $1\frac{1}{2}°$ takes about ten thousand years—so we and our immediate descendants appear to be safe. Even if the two orbit planes were, and remained, exactly coincident, there would probably be many years of grace before the crash. If, when the planet reached the point of intersection, the earth was as much as 10,000 miles ahead or behind, no harm would come of it. The actual danger zone (allowing for the oblique crossing) is about 12,000 miles in total width. Now the circumference of the earth's orbit is 600 million miles, so that there is only one chance in 50,000 of a collision. Fifty thousand revolutions of



San Diego, 9 P.M., 10 seconds, f/1, Schmidt telescope. Lower and Lower

the asteroid would require about 125,000 years. Within a much shorter time, the perturbations of the orbit planes would abolish the dangerous grade crossing.

During the two billions or so of years since the solar system came into being, a good deal may have happened to this tiny planet. It has certainly never hit a larger planet—for in that case it wouldn't be here—but it may well have made a close approach to one of the planets, and been deviated by its attraction from a less sensational, and less dangerous orbit.

Despite these well-founded reasonings, a certain sense of insecurity remains. When we reflect that a projectile weighing perhaps a billion tons, and moving more than 20 miles a second, got by the earth, nearer than anything ever known before to astronomers, without being seen till it was well past, one starts thinking. Why it wasn't seen sooner is clear enough—it came from the region in the heavens close to the sun, and, when nearest, was in the region around the celestial pole, where planet-hunters do not work. If its orbit had intersected the earth's, and if it had come but a few hours earlier or later, we would have had no warning of the impending catastrophe. In any event, it would not have wrecked our planet, nor destroyed all life, or all civilization upon its surface, although it might have spread nation-wide devastation.

IF such a body should be observed at some fairly close approach, prior to the collision, and kept under watch till its orbit was precisely determined, it would be possible to predict the place, as well as the time, of the disaster, and one might imagine a systematic evacuation of half a continent to escape the peril. But the chance of such a thing is so excessively small that, from the actuarial standpoint, astronomers could not honestly ask for the endowment of an extensive "asteroid patrol" to forewarn us.—*Princeton University Observatory. March 4, 1936.*

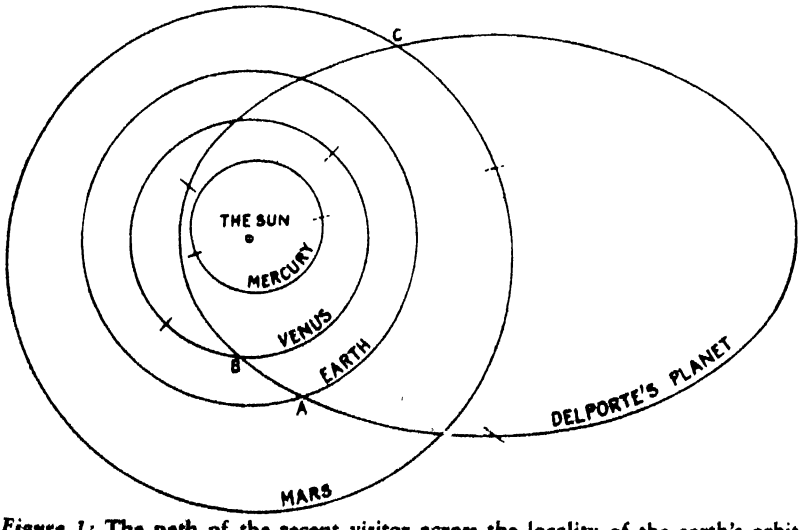


Figure 1: **The path of the recent visitor across the locality of the earth's orbit —though it is not exactly in the plane of the same orbit. See text for explanation**

SEEING IN

Made Possible by the Electron Lens . . . Focuses Electrons as Glass Lens Focuses Light . . . Useful for Secret Signalling . . . Image Fidelity

By VLADIMIR K. ZWORYKIN

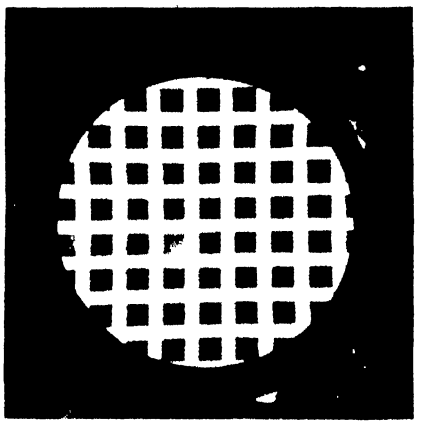
Director, Electronics Research
RCA Manufacturing Company

Editor's Foreword: Seeing in the dark may be said to be one of the ends of research in electronics; in the accompanying article Dr. Zworykin tells briefly yet succinctly of the results that have been obtained. By the system described, it is possible to focus electrons that have been emitted from certain surfaces under the action of light, either visible or invisible. With such an electron lens it was only a step to the development of telescopes that can be used for seeing in the dark.

ELECTRON optics is a comparatively recent branch of the science of electronics, based on the similarity of electron paths through certain types of electric fields and those of light rays through ordinary lenses. This field of study shows that it is possible to shape electrodes in such a way that the electric field between them will act as an "electron lens," capable of focusing the electrons leaving a cathode into an image of that cathode. Such an "electron lens" is found to have properties almost identical with those of an ordinary glass lens. For example, the image must be in focus if it is to be sharp; the magnification is determined by the distance from the electron source or object to the lens and from the lens to the object; furthermore, the image will be inverted as is the case with an optical image. Just as the camera lens must be corrected if the image is to be free from distortion, so must the electron lens be corrected in order to obtain a perfect image.

Certain surfaces, such as cesiated silver, emit photo-electrons under the influence of radiation extending from the ultra-violet, through the visible, and well into the infra-red. If we could watch the electrons leaving such a surface when an infra-red image was projected on it, we would see close to the surface an "electron image" which is identical with our original projected image. However,

Figure 2: In this view of the image formed of a rectangular grid, distortion is present, but in *Figure 3*, at the right, this distortion is eliminated by the simple expedient of curving the infra-red sensitive cathode of the tube upon which the image of the object to be reproduced is thrown. Curved cathodes are shown in the drawings below



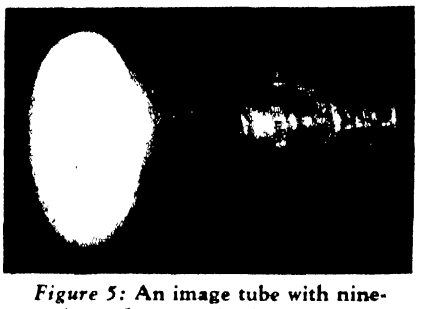


Figure 5: An image tube with nine-inch screen. Note the focusing rings

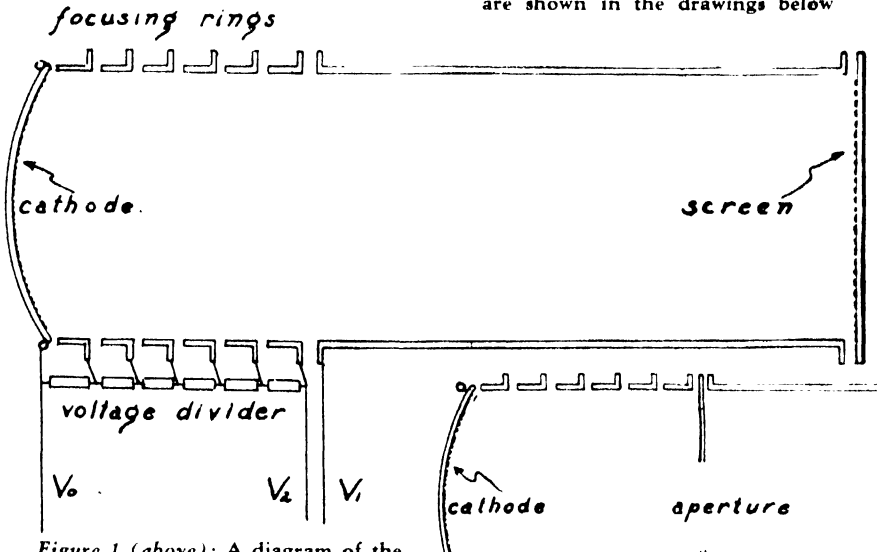


Figure 1 (above): A diagram of the electron lens system described, showing the curved cathode and the anode cylinder to which a high positive potential is applied. The focusing rings and the anode form the electron lens system which is adjusted by varying the potential applied to the rings at the point indicated by V_2

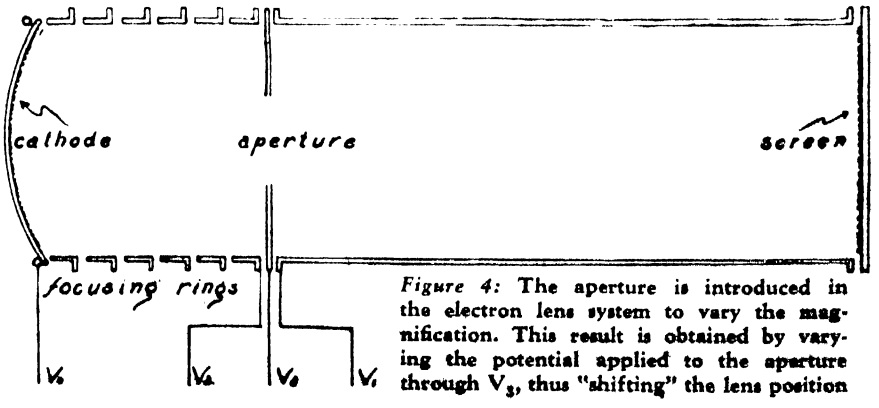


Figure 4: The aperture is introduced in the electron lens system to vary the magnification. This result is obtained by varying the potential applied to the aperture through V_3, thus "shifting" the lens position

THE DARK

these electrons move in all directions so that at a very short distance from the photoelectric surface, the electron image blurs into a random cloud which bears no resemblance to the original picture. At first sight, it seems impossible that these electrons can ever be reassembled into an image again, but at this point electron optics comes to our aid and makes possible the reconstruction of the image. This reconstructed image can then be made visible to the eye by directing it against a fluorescent screen.

The electron image tube makes use of an electron lens system to reassemble the electrons from the photo-electric cathode and to focus them onto a fluorescent screen which becomes luminous when bombarded by electrons. Figure 1 shows diagrammatically how this lens system is constructed. A high positive potential V_1 is supplied to the long anode cylinder to accelerate the electrons to a high velocity in order to produce fluorescence on the viewing screen. The anode, together with the focusing rings, form the "lens" system which can be adjusted by varying the potential V_2. This lens system will image a rectangular grid into an image such as is shown in Figure 2 on the opposite page.

In order to correct for the "pin cushion" distortion and curvature of the image field existing in Figure 2, the cathode is made curved as shown in the two diagrams, Figures 1 and 4. A photograph of the final corrected image obtained by this tube is shown in Figure 3.

Finally, in order to be able to vary the magnification of the lens system, an aperture is introduced between the anode cylinder and the focusing rings. Varying the potential V_3 of this aperture in effect "shifts" the position of the lens, causing a variation in magnification. Figure 4 illustrates this arrangement.

A typical image tube with nine-inch viewing screen is shown in Figure 5. An interesting use to which this type of tube may be put is exemplified in Figure 6. A large aperture lens is mounted so as to image the scene, towards which the telescope is pointed, onto the infra-red sensitive cathode of the tube. This image is in turn reproduced on the fluorescent screen of the image tube, thus enabling the observer to "see" by infra-red radiation. Such a device can be used to test haze and smoke penetration by infra-red, for secret signalling, and other obvious applications involving infra-red rays.

ANOTHER use is in connection with infra-red microscopy. Figure 7 shows an image tube and microscope arranged for infra-red work. The visible image of a micro-specimen as produced on the fluorescent screen is shown in Figure 8.

The next two photographs (Figures 9 and 10) were made by photographing the fluorescent screen of an image tube while an infra-red picture was projected onto the cathode. They illustrate fairly well the resolution and fidelity of the image obtainable.

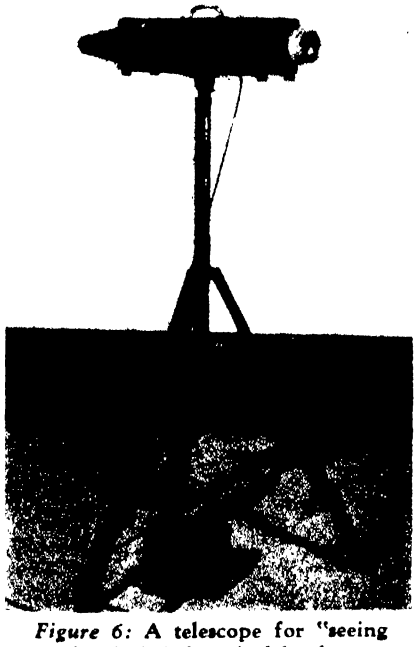


Figure 6: **A telescope for "seeing in the dark," described in the text**

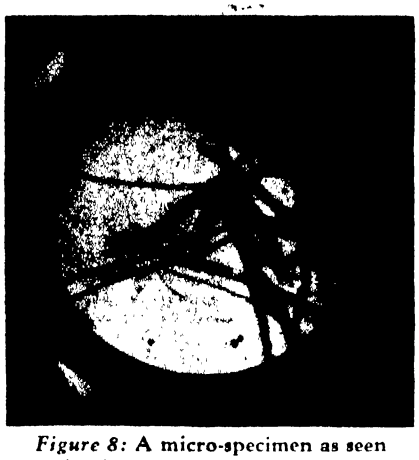


Figure 8: **A micro-specimen as seen with the set-up illustrated below**

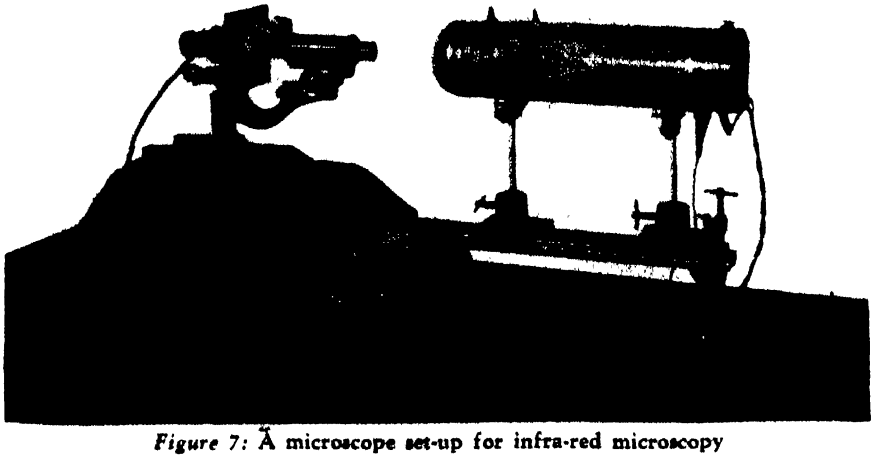


Figure 7: **A microscope set-up for infra-red microscopy**

Figures 9 and 10: **Examples of infra-red pictures as reproduced on the screen of an electron image tube**

A Modern Port

Advance Port at Ocean for French City . . . Wharf Piers Unique . . . Built on Land, Floated, Sunk . . . Engineering Problems . . . Channel Dredge

BORDEAUX, for many generations famous for its wine trade, stands forth today because it is the third largest of the seaports of France. Present interest in this historic city is especially justified because of certain engineering achievements recently wrought by the alert technicists of the Bordeaux Port Authority—accomplishments that have added greatly to Bordeaux' importance as a center of maritime commerce.

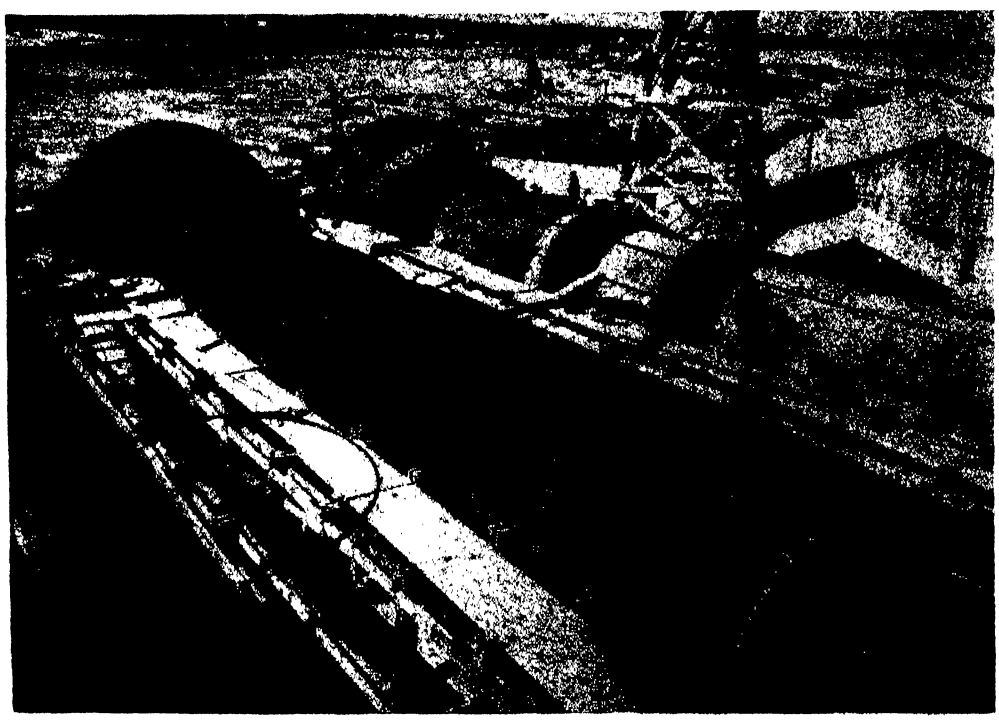
Bordeaux lies inland from the Atlantic Coast of France a distance of fully 62 miles, and is reached by way of the Gironde and the tributary Garonne River, on which the port is located. The run between the open sea and Bordeaux, quite apart from tidal considerations and currents, is at times hampered by fog or by other obscuring conditions of the atmosphere. Low visibility compels reduced speeds and may lead to mishaps of varying gravity. Until latterly, vessels carrying passengers and mail matter have used Bordeaux, itself, as the point of embarkation; and unfavorable weather has occasioned vexatious delays both in the time of arrival or in reaching the open waters of the ocean.

The demand for greater speed and the saving of time led the Port of Bordeaux Authority to call into being an advance port or landing place for Atlantic liners at a comparatively sheltered position just inside the mouth of the Gironde and close to the sea. This halting place for liners is linked by rail with Bordeaux; arriving passengers, mail, and express matter can be quickly transferred to trains and whisked off to Bordeaux no matter what may be the existing navigational difficulties on the water route. Conversely, outgoing travelers, mail matter, and so forth, can now leave Bordeaux hours later than previously and reach their waiting steamer at the advance port and be out at sea a short while afterwards. This makes it possible to save several hours, and is a great convenience to the traveler and of much value to the shipper. The Bordeaux Port Authority has spent approximately 11,000,000 dollars in providing the new accommodations.

THE advance landing place consists primarily of a wharf, 125 feet wide and 1041 feet long, that is connected with the neighboring shore by a jetty that has a length in excess of 1000 feet. The wharf carries a building in which there are commodious waiting rooms, baggage rooms, a restaurant, and other conveniences. The wharf is wide enough for four railway tracks for the accommodation of both passenger and freight trains; there are typically modern facilities for loading and unloading arriving and departing steamers. The connecting jetty carries two tracks and a broad roadway for motor vehicles plying between the landing place and the nearby mainland and the coastal towns. The terminal is far enough offshore to assure at low tide a depth of water alongside averaging more than 40 feet; because the estuary is occasionally swept by strong winds and sizeable waves, the landing place is equipped with hydraulic fenders that serve as buffers between the wharf and moored vessels, so that neither the craft nor the terminal structure shall be damaged by any surging movement.

The construction of the advance port presented difficulties. The landing place had to be set on an underpinning that would have its footing in a bed of firm clay underlying a stratum of sand, gravel, and shattered shells that has a vertical depth of from 20 feet to 30-odd feet—the area frequently being swept by sudden storms. It was manifest that pneumatic caissons could not safely and efficiently be used to get the sustaining piers down to the prescribed seating. That method would take too long and would be too grave a menace to the sand hogs laboring in the working chamber. After considerable experimenting and successive modifications, the chief engineer of the port authority developed unit piers or columns of a unique type that could be sunk into place quickly without employing pressure workers at all.

Most of the piers that are carried deep into the waterbed took the initial form of cylindrical shells having a general diameter of 13 feet, a length of 87 feet, and flaring sections at one end about 25 feet in diameter. These cylinders, nearly 100 of them, were heavily reinforced concrete structures that were built on shore; launched from a broad-gage marine railway so that they



Two of the reinforced concrete cylinders in course of construction on shore and near the site of the advanced landing wharf for steamships. Compare with man on the center scaffold

For Bordeaux

By R. G. SKERRETT

could be picked up, one by one, by a large floating derrick; and transported to their respective points of sinking at the terminal site. The derrick stood each cylinder upright with the flaring end downward and then set it on the bottom of the estuary. At that time each cylinder weighed about 290 tons; and its deadweight was counted upon to make it penetrate the water-bed as the material inside the lower chamber was excavated and transported to the surface.

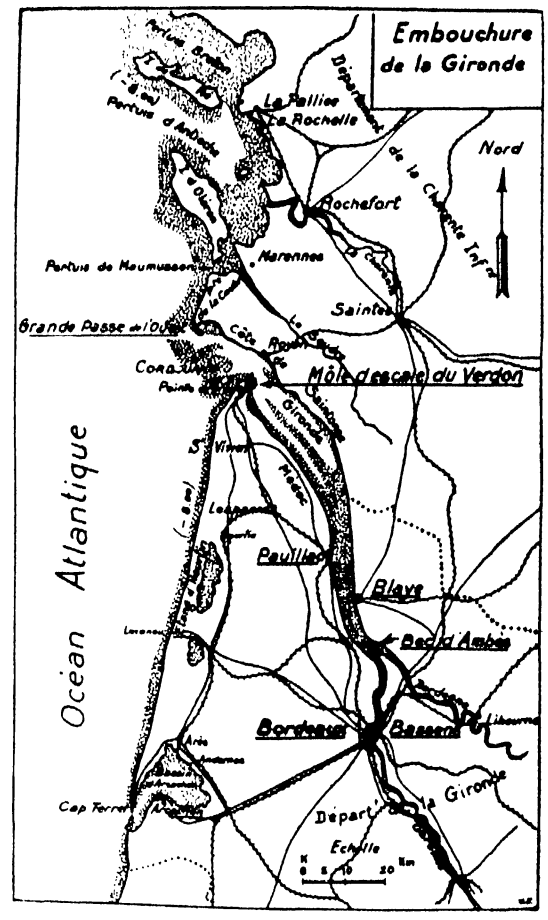
THE excavating of the sand, gravel, and sea shells was done by a number of agitators arranged equidistant on a circle within each cylinder, the intake ends of these pneumatically operated contrivances lying a foot or two below the cutting edge of the flared bottom of the cylinder. Each agitator served the twofold function of stirring up the bottom material and of lifting it to the surface, and it was made up of tubing 10 inches in diameter in which was inserted axially a two-inch pipe that conveyed high-pressure air to its lower end and discharged the air through 30-odd small holes that pointed upward. Both the 10-inch tubing and the contained air pipe reached from the water-bed up to the working platform on top of the cylinder; the bottom edge of the agitator had long saw-like teeth to cut into and to break up the bottom materials.

When compressed air was discharged upward, it produced, in effect, an emulsion that was lighter than the enveloping water, and this unbalancing caused a strong inrush at the bottom of the agitator and a vigorous movement surfaceward — the current being strong enough to carry fair-sized rocks up and overboard at the discharge points of the six agitators.

In the foregoing manner, the materials enveloped by the belled bottom of the cylinder were excavated and the cylinder settled deeper and deeper until it reached and penetrated a few inches into the basic stratum of firm clay. Then, with the cutting edge thus sealed so that external water could not enter the cylinder, beneath the cutting edge, the agitators were used as pumps to lower the level of the water within the cylinder, and that operation caused the outlying water to act with a downward pressure, like a deadweight, great enough to force the cylinder two or three feet into the clay and to anchor it securely there. With that done, the flared bottom chamber was permanently sealed with concrete to produce a plug that would permit the complete unwatering of the interior of the cylinder, after which the cylinder was poured full of concrete to transform the shell into a monolithic column.

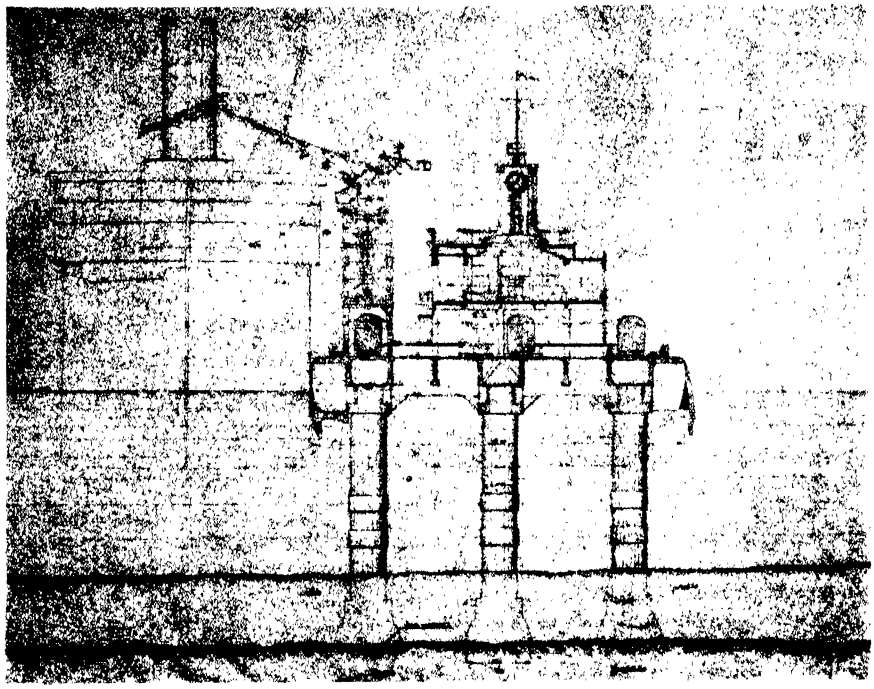
By following the procedure described, unit piers were launched, transported to their prescribed positions, and sunk to their final footholds in the sub-aqueous clay in the astonishingly short period of only two hours on an average. The pneumatic-caisson method would have taken much longer, would have been more costly, and would have been exposed to damaging if not destructive interruptions by abrupt changes of weather.

Having created the advance landing place near the mouth of the Gironde, the Bordeaux Port Authority had next to provide a channel to the sea that would be of ample size to meet increased traffic and the needs of the biggest of French liners that would make use of that base. The existing zigzag channel could not be altered to satisfy the requirements, and the only acceptable so-



The mole, or advanced landing near Le Verdon, lies just inside the mouth of the Gironde

One of the monster, 290-ton pier cylinders being swung upright by a powerful derrick preparatory to starting its journey downward deep into the sand and clay of the water-bed



Transverse section of advance port, with ship tied up. Note the buffers on the side of the wharf; also flared bottom ends of piers penetrating water-bed

lution of the problem was the excavating of an entirely new channel that would cut straight across a wide and far-flung sand bar that lies off the mouth of the Gironde. This meant that dredging would have to be done in the open and often boisterous ocean. To deal with the difficulties, it was necessary to design and build a sea-going dredge of exceptional characteristics and to equip her so that she could do her work without having her dredging apparatus damaged or herself injured in that exacting service.

THE craft built especially for the work is the suction dredge *Pierre-Lefort*. The vessel has Diesel-electric drive, can be completely controlled from a central station, and is capable of receiving and transporting to a point of discharge fully 2600 cubic yards of excavated material. The *Pierre-Lefort* has two large suction tubes or dredges fitted, one on each side of her, to trail as the craft advances. The bottom intake or suction end of each of these tubes is fan-shaped and is arranged to rest upon the bottom and to be dragged along as sand or sediment is drawn into it. Powerful electric pumps within the *Pierre-Lefort* suck up bottom material and water at the same time and deliver the mixture into cargo compartments where the solid matter remains after most of the water is diverted overboard. Gates in the bottom of the cargo compartments are opened when the loaded vessel has been moved to a deep water point for the discharge of the spoil.

Aside from her notably up-to-date equipment and method of propulsion and mechanical drive, the success of the *Pierre-Lefort* is, in the main, due to the unique flexibility of her suction pipes which are so devised that the suction ends can follow freely the contour of the water-bed, while the vessel pitches and rolls in a seaway without causing wrenching or harmful stresses either to the ship or to the attached and dragging suction pipes. Each suction pipe is long enough to do its work in water 65 feet deep. The pipes are each about 21½ inches in diameter and are secured to the vessel at their upper ends by revolving connections. Interposed in the steel pipes at suitable positions there are flexible joints, and the suction or lower end of each pipe is provided with a sturdy ball joint. This exceptional flexibility in her suction pipes has enabled *Pierre-Lefort* to do her work, day in and day out, in the open sea while waves were running that had a height of 11 feet and more—the dredge going steadily forward at a rate of two knots against a current that had a velocity of five knots. The ship was able to load and to discharge herself 15 times in the course of 24 hours. This included the time taken to run to a dumping point and to return to her place of dredging.

ALL told, the *Pierre-Lefort*, and an older modified steam dredge, have excavated the new channel by which the Gironde is now linked with the Atlantic. That channel is more than half a mile wide, 2½ miles long, and has a depth of not less than 30 feet at low tide. The cutting of that channel required the excavating of about 10,000,000 cubic yards of material. Both the building of the advance port and the dredging of the new channel have increased to a marked extent the advantages of Bordeaux for maritime trade; but from a technical point of view, what has been done there is of outstanding interest to the entire engineering world because of the ways in which natural difficulties have been mastered. Both undertakings have been under the direction of François Lévêque, chief engineer of the Port of Bordeaux Authority; each project was attacked in a practical way only after much preliminary study and experimentation.

The completed project bears witness to the thoroughness with which that study was made, as well as to the ingenuity displayed by the French engineers in performing an outstanding job under great difficulties.

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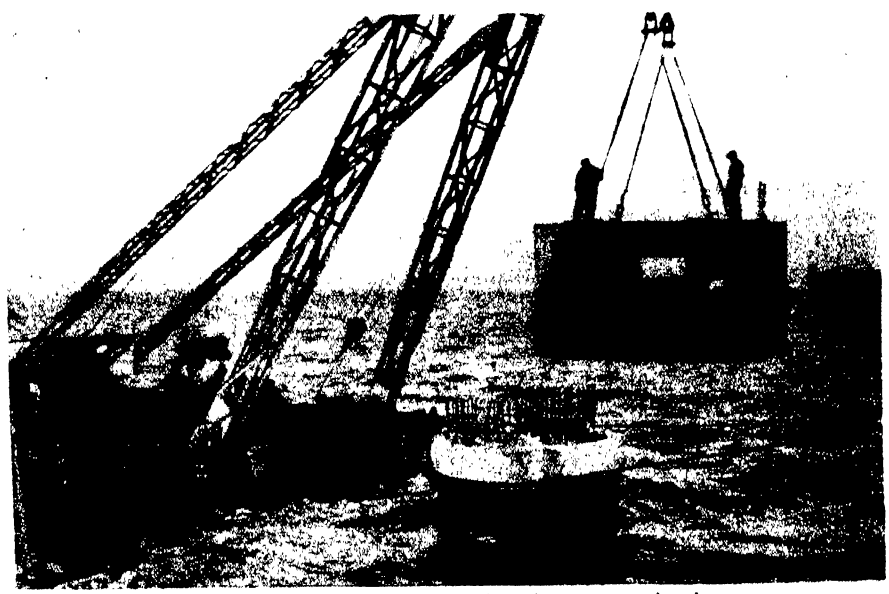
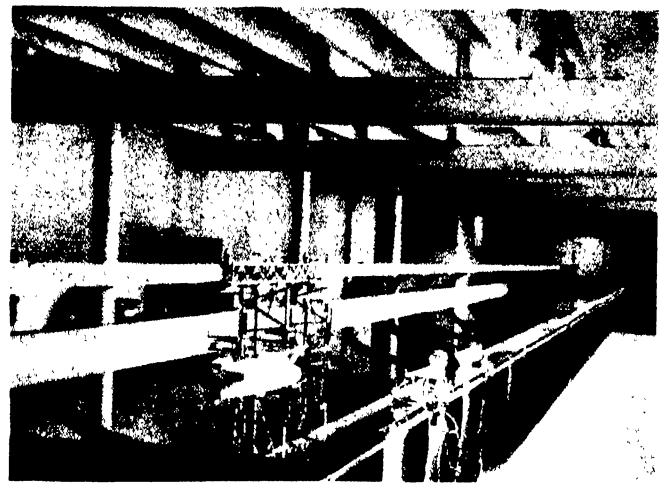
R. G. Skerrett, author of the preceding article, has written another, for early publication, on the enormous Fort Peck Dam project. It is an unusually interesting and lucid story of a significant engineering feat.—The Editor.



A seated cylinder—a steel-encased monolith—about to receive its concrete cap for the immediate support of the deck and superstructure of the advance port

Towing Tank

Tests Ship Scale Models



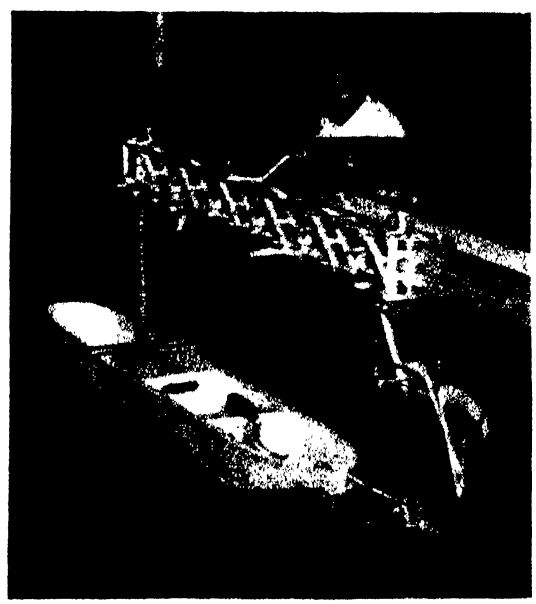
A general view of the towing tank described in the accompanying text

THERE has recently been put in full operation at Stevens Institute of Technology, Hoboken, New Jersey, an experimental towing tank, equipped to make accurate resistance measurements on ship models, and marking the culmination of four years of investigation by Professor Kenneth S. M. Davidson and other members of the Department of Mechanical Engineering.

What is of particular interest in this connection is the fact that testing will be done with small models whose advantages in the matter of cost and convenience are immediately apparent. In addition to fundamental research in the field of hydrodynamics, the tank is available for commercial testing.

The towing tank is 100 feet long, 9 feet wide, and 4.5 feet deep, of semicircular cross-section. It is built of ¼-inch copper-bearing steel plate set into cradles of three-inch channels. The whole structure is carried on two lines of 15-inch I-beams, which in turn are carried directly on specially built foundations in the cellar under the building. This precludes the possibility of building vibration being transmitted to the tank. It is set down slightly into the floor so that the top is at a convenient height for observation.

The towing carriage is drawn along a stainless-steel rail by an endless cable. The cable passes over a stepped pulley, directly connected to a gear box, which in turn is connected to both an alternating-current and a direct-current motor. The direct-current motor is for acceleration and reversing and the alternating-current drive is for constant speed towing.

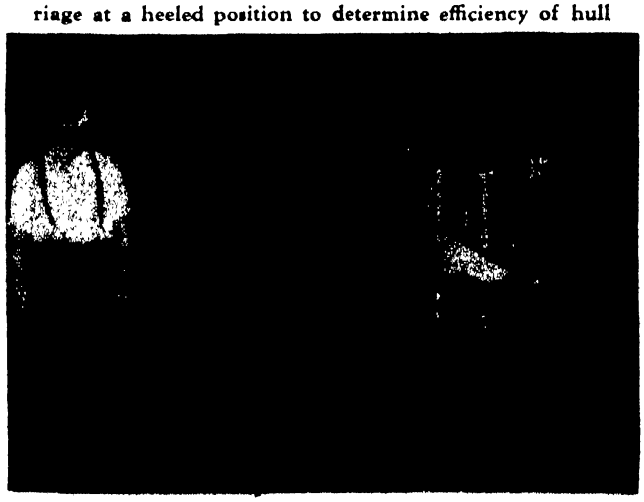


Testing a model of a Hog Island type of ship in the tank. Note bow waves and instruments

The measuring apparatus in general consists of a longitudinal dynamometer and two lateral dynamometers, all of which can be mounted on the carriage at once. In addition to measuring longitudinal resistances of ship models in the usual manner, combinations of both longitudinal and lateral forces can be obtained for sailing yacht models in various positions. These positions include heel angles up to 45 degrees and leeways up to 10 degrees. Measurements can be taken to determine the centers of lateral resistance. A large dynamometer for obtaining hull resistances of full-size yachts is also part of the equipment. Included in the auxiliary equipment is an apparatus for calibrating the dynamometers against dead weights.

It is believed that the Stevens tank is a valuable supplement to existing ship model towing equipment in this country. It is thought that the small tank will be of decided value in the hull design field of both sailing yachts and commercial vessels. This can easily be seen when one compares the cost of models. On a particular project several small models with suggested differences could be built and towed for the cost of one large model and its test. This would allow considerable latitude in trying hull changes.

Below: A scale model of a racing yacht is held by the carriage at a heeled position to determine efficiency of hull



Setting up the dynamometers on the towing carriage to measure longitudinal and lateral resistance of a yacht hull

THE MYSTERY OF THE

A Particle or Entity which May Turn Out to be a Nonentity . . . The Law of Conservation Apparently Fails . . . What Scientists are Wondering

By JEAN HARRINGTON

IF anyone ever compiled the Ten Commandments for science, the law of conservation of energy would surely be included among them. If ever there was a law within which nature seemed confined, it was the one which stated that energy may change its form, but it cannot be created nor destroyed.

Energy is the chameleon of science. It appears as heat, as light, as motion. It is stored chemically in the food we eat, the air we breathe, and the coal that keeps us warm. It sends the electric current humming along our telephone wires, and it annoys our neighbors via our radio loudspeaker. It is latent in all matter, for science has shown us that mass and energy are only two different forms of the same thing. Yet whatever its form, it remains intrinsically the same: the capacity to do work.

When we drive a car, the chemical energy of the gasoline is turned first into heat, and then into the mechanical energy which operates the pistons and turns the wheels. When we stop for a traffic light, the car's energy of motion is transformed back into heat in the brake bands, the tires, and the road.

Radiant energy of the sun is stored in growing plants by a chemical process known as photosynthesis. The eater, in turn, stores the supply in brain and muscle, ready to be put to use for mental or physical activity.

ENERGY changes such as these can be similarly analysed in many another cycle. Often the amounts going into each successive form can be exactly measured. The first scientist to suspect that these many different aspects of energy are equivalent was Benjamin Thompson, a British sympathiser who escaped from America during the Revolution. He became a military engineer for the Bavarian government, which bestowed upon him his familiar title of Count Rumford. Late in the 18th Century, he was supervising the task of boring cannon, when he noticed that the brass became hot and stayed hot as long as the process continued. He experimented with a crude calorimeter, and concluded that motion could be turned into an equivalent amount of heat. This observation inspired a series of experiments which culminated a half century later in the acceptance of the law of conservation of energy.

Today no one can say whether that law holds universally or not. The study of atoms has brought to light many cases where previously accepted laws and theories have seemed to fail. It is as if the atom assumed the privilege of misbehaving within its own tiny, private sphere. Not the least of its sins is its apparent disregard of the law of conservation of energy.

To understand the how and why of this atomic peculiarity, we must first know a little about radioactivity. There is a certain group of heavy elements—

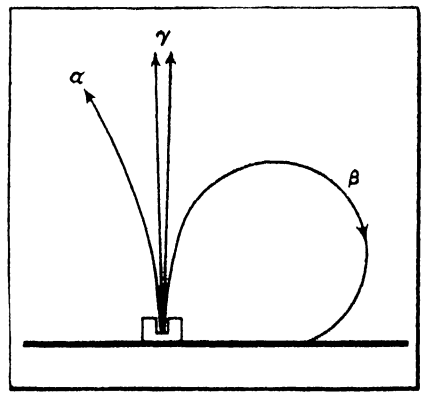


Figure 1: A diagrammatic representation of the three types of rays emitted from radioactive elements

uranium, thorium, and radium are typical examples—which are by nature unstable, and which are breaking down continually into lighter and more stable elements. The reason for this spontaneous disintegration is not thoroughly understood, but it has to do with unbalanced energy conditions within the nucleus of the atom. For the heavier elements, the nucleus contains so many protons and neutrons that the forces holding them together are ill-adjusted and easily upset. In such a case, the nucleus will try to rebalance and stabilize itself by emitting some kind of particle or radiation. A minute quantity of a radioactive element may take anywhere from a few minutes to a billion years to disintegrate, depending upon how easily its equilibrium is upset, and how great the forces a particle in the nucleus must overcome in order to escape.

A nucleus may choose one of three ways to throw off some of its excess internal energy, for there are three types of spontaneous emission. When these were discovered by Becquerel, back in 1896, scientists thought they were something new and mysterious in the way of radiations, and named them vaguely enough—alpha, beta, and gamma rays. But later investigation showed them to be old familiar friends, coming from a new and different source. The alpha rays proved to be streams of helium nuclei, massive particles with a positive charge of two. The beta rays turned out to be nothing but the well-known negative electrons, while the gamma rays were not particles at all but appeared to be similar in nature to light and X rays of a very short wavelength.

THERE is a very neat little diagram (Figure 1) which shows the differentiation of the three kinds of rays. Suppose we have a little piece of radium in an open metal container. If we put this in a strong magnetic field, the effect will be to sort out and separate the rays as they emerge. When an electrified particle encounters a magnetic field, a force is set up which tends to make the particle travel in a curve instead of a straight line. Now the alpha particle has a positive electric charge, so its path is bent in one direction; while the beta particle has a negative charge, and is sent off in the opposite direction. The reason its path is so much more curved is that it weighs so much less than the alpha particle, and hence responds more easily to the deflecting force. The gamma rays, being electrically neutral, are not affected at all by the magnetic field, and continue their straight line course.

Actually, this experiment could never be carried out, because the conditions for detecting the rays must be adapted for each of the three separately. Moreover, no single radio-element ever gives off all three radiations simultaneously. A nucleus may emit an alpha or a beta particle, but not both together, although gamma rays may accompany either particle.

In Figure 2 is a sketchy representation of a typical disintegration family—

NEUTRINO

part of the radium series. It shows how a nucleus breaks down in successive stages, by one way or another, until it reaches a stable form. Radium A, at the left of the diagram, emits an alpha particle and thereby becomes a new element known as Radium B. This in turn gives up an electron and becomes Radium C. The latter is a bit peculiar. Most of its atoms—more than 99 percent, in fact—emit beta particles and become atoms of Radium C′. A tiny, independent fraction, however, chooses another path and turns itself into C″ by shooting off alpha particles. The end product of both is the same thing, both C′ and C″ eventually becoming Radium D. This is a stable isotope of lead, and there is no further disintegration.

To be strictly accurate, we should mention still a fourth kind of radioemission. When elements are made artificially radioactive, they sometimes emit positrons or positive electrons. But these need not concern us in our study of energy conservation. It is the beta rays which concern us most.

Now every atom of a given element is perfectly similar to every other atom of the same element. Each contains the same number of electrons revolving around the nucleus. Each contains the same number of protons and neutrons within the nucleus. And with each is associated a certain characteristic amount of energy. Thus, when a nucleus of one element loses an alpha or a beta particle, it changes itself thereby into the nucleus of a quite different element with a different characteristic energy. Each transmutation, then, *must involve the loss of a certain fixed amount of energy.*

The loss may be accounted for in several ways. In the first place, the very mass of the ejected particle represents a large amount of latent energy. The velocity, and hence the kinetic energy of the particle, accounts for an additional loss. If these two are not sufficient to make up the required energy difference of the two nuclei, a gamma ray may be thrown in to even things up. The gamma ray may possess varying amounts of energy, depending upon its frequency or wavelength.

We have now arrived at a point where we may state our problem, and the gist of it is this: Given two identical nuclei, each of which emits an identical particle, each thereby becoming identical nuclei of a different kind, the energy loss in both cases should be exactly the same. This is true for alpha emission, *but it does not always hold for beta emission.* At this crucial point, the law of conservation of energy apparently fails.

How do we know this is true? Returning to our two identical nuclei, we shall submit them to a test which should show whether or not the energy loss really differs in the two cases. The experiment, devised by Ellis in 1924, is similar in theory to the one sketched in the first diagram; but this method is practical, for it is designed to study only the beta rays (Figure 3). A tiny speck of, let us say, Radium B, is placed in a metal container, next to a heavy lead block which bears a photographic plate. The whole apparatus is placed in a vacuum box in a strong magnetic field. The rays passing through the slit are bent by the field, just as before, so that they fall on the plate, where each electron leaves its "photograph" as it falls.

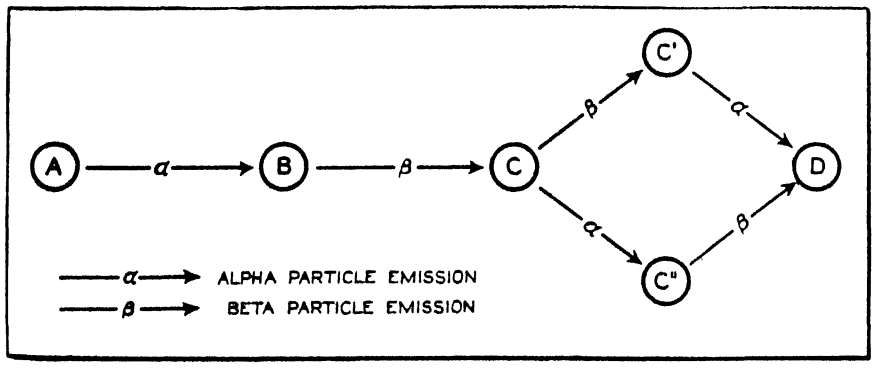


Figure 2: **A typical disintegration series. Part of the radium family, from Radium A to Radium D, which is an isotope of lead. Explained in the text**

Suppose for a moment we have just two nuclei of Radium B and two beta rays, *X* and *Y*. They have the same energy due to their intrinsic mass, and if they had the same velocity, they should be deflected the same amount by the magnetic field and land on the same spot on the film. The fact that they do not proves that they must have different energies of emission, and there are no gamma rays in this case to make up the difference. Yet both parent nuclei turn into identical nuclei of Radium C.

Of course we could never get two isolated particles such as *X* and *Y*. There are many thousands of them, but they behave in the same way, perhaps no two among them having the same velocity. The developed film (Figure 4) shows a wide spread of energies, ranging continuously from a maximum which corresponds to the exact difference in energy level between the two nuclei, down through 6 or 7 million electron volts.

Because this apparatus sorts out electrons of different energies, just as a prism sorts out light of different wavelengths, it is called a beta-ray spectrograph. Indeed, the developed plate looks very much like a spectrum of light.

UNFORTUNATELY, the experiment is complicated by the so-called secondary beta rays—electrons which do not originate inside the nucleus, but are knocked from their orbits outside the nucleus. These, however, can be fairly easily identified. Instead of having a wide range of unrelated velocities like the electrons from the nucleus, they fall into various speed groups, depending on which orbits they come from. Many of them land, therefore, on the same region of the photographic plate, leaving a band or spectrum "line" which is darker than the background, as at *A*, *B*, and *C* in Figure 4, and is easily distinguished

But what of this continuous background? Why do the nuclei send forth electrons of such different speeds? And what becomes of the excess energy when the electron is traveling slower than it ought? That is just what the scientists are wondering. If part of that energy simply disappears, leaving no trace of its passing, then the conservation law is an empty formula. Naturally, the investigators are reluctant to let it go at that. And so there have been proposed a number of alibis which seek to absolve the atom from its asocial behavior.

The explanation which has aroused the most interest to date introduces a new particle, the neutrino, into the atomic family. Unfortunately, the neutrino, if it exists at all, is extremely shy and retiring. It has never been observed, and it has consistently evaded attempts to track it down. But if there really is such a particle, it will prove a godsend to the defenders of the energy conservation law.

The theory of the neutrino is simple enough on the surface. We have pointed out that the mass of the electron accounts for part of its energy. This is a by-product of Einstein's law that mass and energy are only two different forms of the same thing. When the electron is going too slowly to use up all the ex-

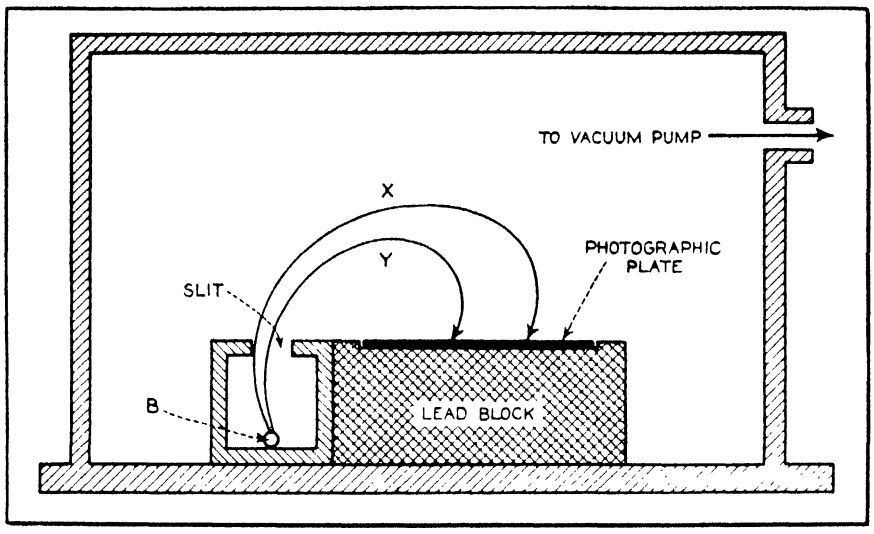


Figure 3: **A diagram showing how Ellis's magnetic beta ray spectrograph works**

cess energy within its parent nucleus, suppose that the nucleus also emits another particle, with just enough mass to make up the difference. If this particle, our neutrino, had any electric charge, it should be easily detected in a magnetic field. Since this is not true, we must assume that it has no charge, and is just a neutral mass like the neutron. On the other hand, if it were as heavy as the neutron, again it should be easily detected, because it would leave the nucleus so much lighter. As a matter of fact, scientists have made the startling assumption that the neutrino at rest has no mass at all!

THIS sounds absurd, of course, until we remember that a photon, or particle of light, has no detectable mass, but still has energy and can be converted into mass upon occasion. Moreover, there is another scientific law which has bearing here: the peculiar fact that the faster a body moves the heavier it is. This effect is so slight at ordinary speeds that it cannot be detected. A freight train going at a 50-mile-an-hour clip weighs only a tiny fraction of an ounce more than it does at rest. But bring a body up close to the speed of light—186,000 miles a second—and its mass increases very appreciably.

These particles shooting off from atoms come as close to the speed of light as anything we know of except light itself. So if our neutrino, starting out from nothing, and working up to a velocity of 100,000 miles a second, may acquire for itself a small but very important mass.

Since the velocity of the beta ray is a variable quantity, differing from atom to atom, naturally the neutrino must also be a variable. The two are complementary mates, the one making up the deficiencies of the other, and the energy of the two always coming to the constant total we need to save our conservation law.

Up to date no one has been successful in devising an experimental technique sensitive enough to catch the neutrino up to its tricks, if, indeed, there is one to catch. All we have on it now is circumstantial evidence. For instance, Dr. Kenneth Bainbridge of Harvard reported recently to the American Physical Society the discovery of certain pairs of isobars which, he claims, could not exist unless the neutrino also exists. Isobars are elements identical in weight but differing in chemical properties. That is, their atoms contain the same total number of protons and neutrons, but in different proportions. By a complex mathematical development, it has been apparently shown that pairs of isobars differing in atomic number by only one are a theoretical impossibility, unless a neutrino weighing more than zero is a factor in their creation. Dr. Bainbridge and his associates, using a mass spectrograph, a precision instrument for weighing atoms, have definitely isolated three such pairs. This is, of course, indirect evidence for the neutrino hypothesis, and it is not entirely above question.

The neutrino theory was first proposed by Pauli; since then the great Italian physicist Fermi has tried to put it on a mathematical basis which would conform to wave mechanics, the quantum theory, and all the other theories of the nucleus. Unfortunately, the neutrino has of late fallen into disfavor, principally because Fermi's mathematics predict the wrong results. In science, a theory may be logically possible, but if it is not mathematically sound, then alas for logic! The neutrino worked into so neat a case for the law of energy conservation that it is rather a pity to discard it. But it seems we must, at least for the time being, until someone puts it on a sounder mathematical basis, or, better yet, actually finds it.

Two German physicists, Beck and Sitte, have put forth an alternative theory, which likewise has its good points and its bad. Instead of a neutrino accompanying each beta particle, they suggest that a positron or positive electron is its chosen mate. Dirac has shown that electrons and positrons may be created in pairs out of other forms of energy, so there would be nothing strange in this. Instead of actually escaping from the nucleus, as the neutrino is supposed to do, the positron is immediately recaptured by the nuclear forces, and is thenceforth divorced from its partner electron.

This theory does not fit well, either, with the experimental facts, without some intricate and not thoroughly justified mathematical juggling. It has received less interest and attention from physicists than the more spectacular neutrino theory.

A third school of thought has attempted to show that the law of conservation of energy does not necessarily always hold true. We have mentioned before in another article the principle of probability, the underlying theory of wave mechanics, which has already reduced many of our physical laws to expressions of *average* rather than absolute behaviour. Perhaps energy conservation is also only an average condition.

It seems improbable, however, that the law should be broken only, so far as we know, by the beta rays. Such consistency in misbehavior is rather incompatible even with the law of probability.

I DO not claim to set myself up as a prophet of science, but I am willing to hazard a guess that none of these three theories will hold out much longer. Probably the ultimate solution of the beta ray mystery is still forthcoming, when some scientist or other thinks up a better idea; an idea perhaps just as understandable as any of these, but which will better fit the facts. And the rest of the scientific world will be left thinking, "I wonder why that didn't occur to us before?"

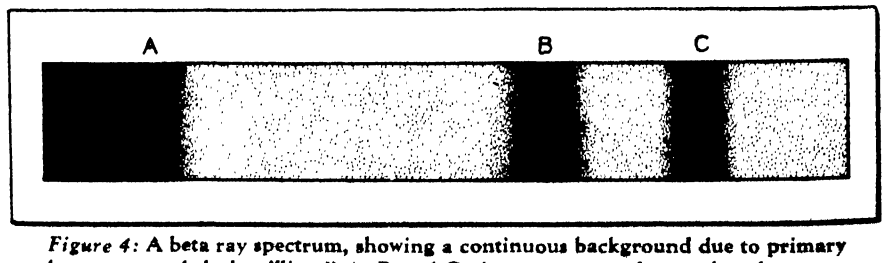
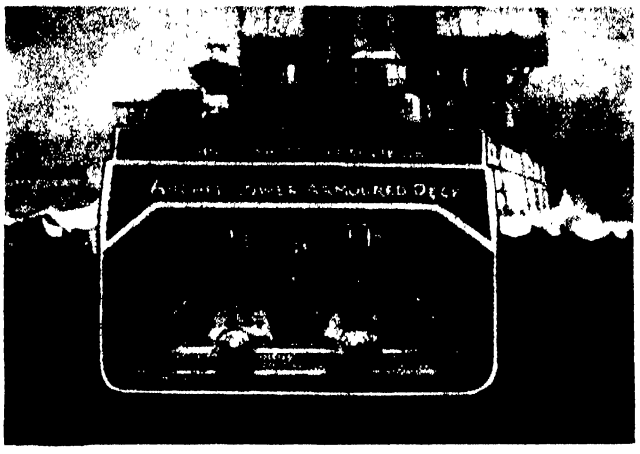
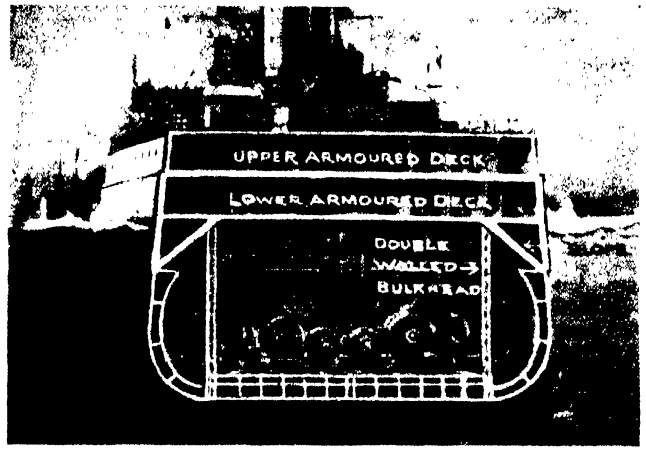


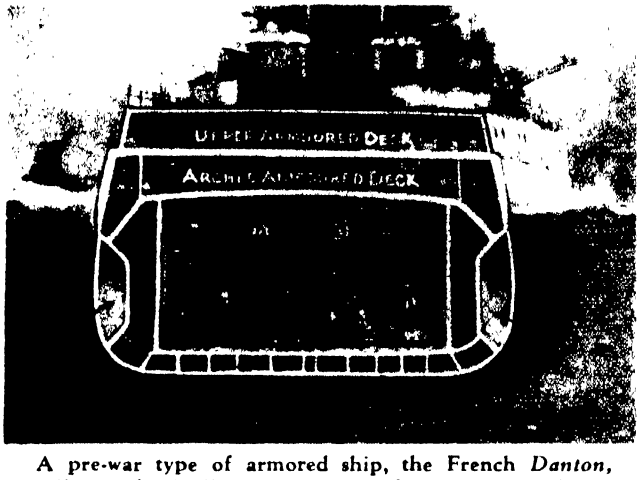
Figure 4: **A beta ray spectrum, showing a continuous background due to primary beta rays, and darker "lines" A, B and C, due to groups of secondary beta rays**



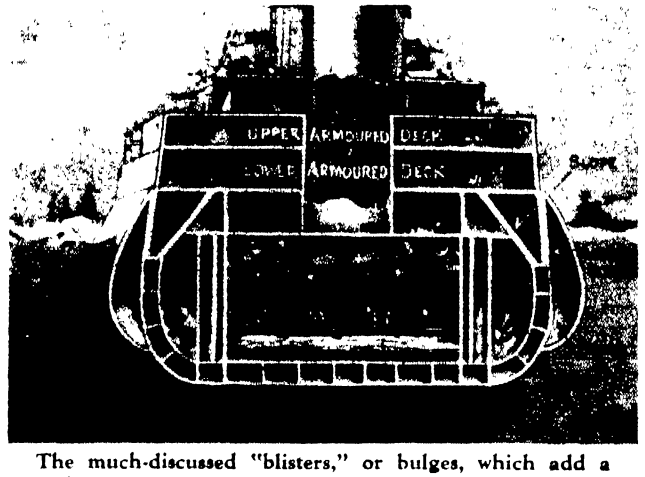
The "caisson" system worked out by Emile Bertin, the French naval designer. Intended as a defense against gunfire, it has been adapted for protection against air bombing. Modified, it is followed by all navies of the world



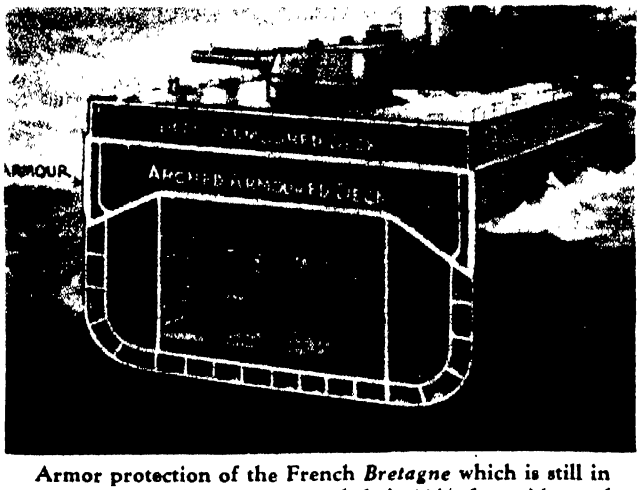
How the United States Navy does it. In this system, the slopes (*glacis* or *talus*) are thicker than the lower armored deck itself. The double hull and strong bulkheads provide protection against all kinds of underwater explosions



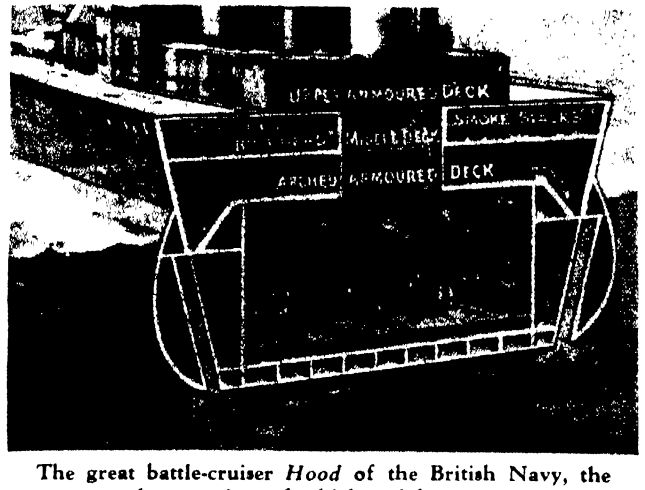
A pre-war type of armored ship, the French *Danton*, utilizing the Emile Bertin system of protection—a "caisson" within the hull—as a protection against torpedoes which can be launched from aircraft as well as water craft



The much-discussed "blisters," or bulges, which add a cushion to absorb the shock of underwater explosions. This section, of the British *Royal Sovereign*, shows good internal protection through extreme compartmentation



Armor protection of the French *Bretagne* which is still in commission. The main armor belt is 13½ feet wide; and there are two protective decks plus a complex system of interior bulkheads, all of which protect against torpedoes



The great battle-cruiser *Hood* of the British Navy, the armor and protection of which weighs 13,800 tons, or one third the vessel's load displacement. Note the liquid "mattresses" that are formed by the open-at-bottom bulges

THE CAPITAL SHIP'S STRUCTURAL DEFENSE

THAT the mightiest units of world navies of today are proof against surface, underwater, and air attacks is a hotly discussed question. Yet certain battleships are well-nigh invulnerable. Why this is possible can readily be imagined after a study of the extent to which compartmentation and armor plating are achieved in the capital ship sections shown above. While the hulls may appear thin, they are in reality quite heavy, the armor belts at the water-line being up to 16 inches in thickness. From drawings by C. E. Turner, through the courtesy of *The Illustrated London News*.

'Fairbottom Bobs'

Oldest Newcomen Engine . . . Salvaged, Shipped to America from England . . . Restored . . . Operating Once Again . . . A Mechanical Link with the Past

By F. D. McHUGH

MORE than 40 years ago, at the very time when Henry Ford was building the car that was to revolutionize land transportation, there appeared in Scientific American an article called: "A Newcomen Steam Engine" and in it the unnamed author commended the directors of various technological museums for their attempts to "give the present generation a vivid idea of the triumphs of some of the great mechanical minds long passed away" through models based on old drawings and engravings. He pointed out, however, that valuable as these models were, they lacked actuality and left a doubt in the mind of the spectator of their literal accuracy, and, further, lamented the fact that more actual examples were not obtained and preserved for posterity.

"At the present moment," the article read, "there is a specimen of an engine built by Newcomen, of Dartmouth, in 1705, rusting away in the open air for want of a friendly hand being put forth for its preservation. . . . The date of its erection in Fairbottom Valley, half way between Ashton-under-Lyne and Oldham, is uncertain, but it was probably toward the end of last century. It is still on the original site."

In the foreground is the "wagon" type boiler that replaced the original "haycock" type which powered Fairbottom Bobs

There followed a technical description of the engine, in which the interesting point is made that to keep the piston joint in good working order, the top was commonly packed with horse dung.

"It appears probable," the article concluded, "that this is the oldest engine in existence, but it is in a most dilapidated state."

It was "Fairbottom Bobs" the author was describing, but he did not know it by that name. This is how it came by its nickname, according to local tradition: When motionless it was hidden from the view of the surrounding countryside by low hills of slag, built up when the valley was still a prosperous mining district, but when it was in operation the beam-ends could just be seen bobbing up and down against the horizon, like a couple of bent old rustics nodding over their cups.

Thirty-four years elapsed between the time that article was written and the time when it was brought to Henry Ford's notice. Meanwhile, the obscure farmer-engineer of Dearborn had become an international figure and the "ruler" of one of the world's greatest industrial empires.

After all those years old Fairbottom Bobs, now well past the two-century mark, still stood its ground, still awaited the "friendly hand" that was to rescue it from oblivion, and the old residents of Fairbottom Valley who had lamented its passing themselves had long since passed from the scene.

Mr. Ford, who had operated (stationary) engines long before he began putting them on wheels, immediately recognized the historical importance of the Newcomen—the first practical form of reciprocating steam engine—and resolved that if possible he should have it as the keypiece of the power exhibit in the great museum then taking form at Dearborn.

When he visited England in 1928, one of his first concerns was to make a pilgrimage to Ashton-under-Lyne, not far from the famous Lancashire cotton city of Oldham, finally reaching the site of the old engine.

AS was to be expected, old Fairbottom Bobs, after working some 70 years in all sorts of weather and standing derelict another 100, was not much to look at when Mr. Ford first viewed it. The beam had collapsed, the connecting chains had disappeared. All that remained visible of the structure was the masonry column that had supported the beam trunnions, the cylinder and its piston rod, which had fallen sideways, the trunnions and their steps and old curved wooden arm, sundry iron work from the beam, and the wreck of an old "wagon" boiler. But that was enough. Mr. Ford had no difficulty in envisioning this great mechanical link with the past restored in its entirety.

The trustees of the estate of the Earl of Stamford, apprised of the purpose for which Mr. Ford desired the engine, proved to be in utter sympathy with the idea; in fact, insisted that Mr. Ford accept the famous engine as a gift. Only there were, of course, many formalities to be complied with and legal technicalities to be straightened out.

The negotiations between Mr. Ford's agents and Lord Stamford's trustees endured a year and had assumed the proportions of an international treaty when,

in July, 1929, everything having been most satisfactorily arranged, the work of taking down and picking up the remains of Fairbottom Bobs and preparing it for shipment to America began.

It was no easy task—an engineering job in itself. On one side lay slag hills crossed only by narrow footpaths. On the other flowed the Medlock, normally a gentle stream about 12 feet wide, which runs down an 80-foot channel it has cut for itself through the slag heaps and can easily be crossed on stepping stones. After a few hours of rain, however, it becomes a raging torrent.

To get trucks and derrick to the site, and later to remove the carefully boxed remains of the old boilers and 170 tons of masonry and machinery, Mr. Ford's engineers had to build a temporary bridge and lay a narrow-gage railway across it. Several times during the building of the bridge the workmen had to abandon their tools and run for their lives and then, when the water had subsided, recover tools and planks many miles downstream.

MOTHER Nature gave the Ford forces valiant battle every step of the way. She had spun a web of heavy interlacing branches of ivy about old Fairbottom Bobs. She had sent up tall trees to hide her century's labor and thrust their destructive roots into the crevices of the stone foundation. Chains and other parts of the engine had fallen into the 220-foot pump shaft.

When the engine had been dismantled and all visible parts carefully examined, cataloged, and crated, the work of recovery was only well begun. Next came the turning up of the soil for yards about to uncover parts of the operating gear that through the years had gradually become buried in the earth's surface: cylinder castings, reduction box, jack head pump, suction flange, top and bottom motion shafts, operating levers and the like. It was long, hard labor but well rewarded; as each new find came to light and revealed to the patient searchers more precise knowledge of the actual mechanism of the engine, it was greeted with much enthusiasm.

Next came the removal of the central column, a 14-foot pylon built of some 450 heavy blocks of stone. Each stone was marked in position with identifying colored numerals.

Now began the attempted search of the pump shaft itself. Photographs of Fairbottom Bobs taken 60 years before plainly indicated that certain missing parts must have tumbled down the well when the engine's superstructure fell apart. To reach the bottom of the 220-foot shaft, filled with water to within 18 feet of the surface, was, the searchers realized, a well-nigh hopeless task, and even if successfully accomplished probably would prove a fruitless one, since several generations of Fairbottom boys had amused themselves by tossing bricks and other objects into the well and any pieces of value at the bottom in all likelihood would now be buried under mud and debris. Some of the missing parts, however, might be wedged across the shaft and on that chance heavy grabs were lowered.

Fairbottom Bobs in its original setting. This and the illustration on opposite page are from 60 year old photos

The results of this method were nil, so a staging was built down to the water's edge and there a force pump capable of lifting 200 gallons a minute set up. At first this effort seemed to be meeting with success. The water level rapidly fell 10 feet. But it fell no farther. Seepage from old mine galleries far below now easily overcame the pump. The engineers conceded this final minor victory to the forces of nature, and though the water was probed with an 18-foot boathook from the lowered level nothing of value came to light.

They were satisfied, and well might be, for with the material they had and the aid of careful measurements and photographs, the reconstruction of what possibly is the oldest engine on earth could easily be achieved.

Carefully (and somewhat hastily, because souvenir-hunters were by that time visiting Fairbottom Valley in increasing numbers) the precious relics were boxed and moved across the wooden bridge to waiting railway trucks and shipped to the docks. Meanwhile, as a gesture of friendliness toward the generous trustees of the Earl of Stamford, Mr. Ford ordered a new footbridge erected near the site of the one washed away during the operations, so that today, no matter how merrily the Medlock overflows its banks, the cottagers of the valley can reach their homes dry-shod.

ON November 2, 1929, just four months after operations were begun at Ashton-under-Lyne, Fairbottom Bobs was shipped to the United States. Some months later Mr. Ford's English agents were enabled to acquire another Newcomen type atmospheric engine—one of the three known to be working throughout the world—and this one a particularly interesting specimen, since it has a separate condenser, and is thereby unique. In the neighborhood they found an old "haycock" boiler, of the type used originally with Fairbottom Bobs, the "wagon" boiler having been a later "improvement." This boiler was still in service—as a water tank. It was bought and shipped to Dearborn—where it gives the final and authentic touch to the restored masterpiece of Thomas Newcomen, the blacksmith who gave the world the first practical means of draining mines.

In the operation of the Newcomen atmospheric engine, steam at little or no more than atmospheric pressure was admitted to the cylinder through a valve, a counterweight on the beam raising the piston. A jet of water then entered the cylinder, condensing the steam. Atmospheric pressure, forcing the piston down, did the work on the pump. The next entry of steam expelled the condensed water through a valve.

Fairbottom Bobs has been perfectly restored, with the use of only such new material as was necessary to put it in working order again. And it does work today, or could be made to work, as well as ever it worked in the old Cannell Colleries in Ashton-under-Lyne.

ARCTIC

The cliff which is the site of the richest radium strike to date, at Great Bear Lake in the Canadian Arctic. The productive vein follows along the water's edge

Prospectors working on a claim in the Great Bear Lake mining field

Ores of the Canadian Arctic . . . By Air and Water and Rail to the South . . . Refined and Made Ready for Hospital Use Near Toronto

AT a well guarded factory in the small town of Port Hope, Ontario, 60 miles east of Toronto, chemists are busy extracting the world's most precious mineral from tons of carefully guarded and protected rock which have journeyed nearly 3000 miles by air, water, and rail. Radium sells for 70,000 dollars a gram, or about 2,000,000 dollars an ounce.

Radium is being manufactured in Canada from ore found on the shores of Great Bear Lake, on the Arctic Circle. Ontario hospitals are using radium mined in the far north, and the medical world is looking to the Canadian Arctic to supply large quantities of this valuable mineral so necessary to-day in the treatment of cancer.

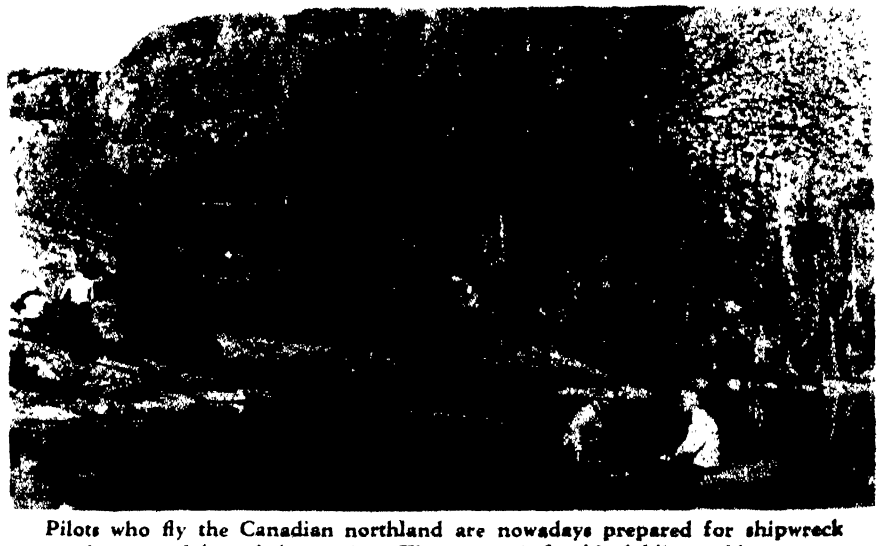
There is a jump of nearly 3000 miles from the Port Hope radium plant to the mining camps on the shores of Great Bear Lake. It used to take the better part of a year to get into the country. Now, from the mine to the plant, with favorable flying weather to Edmonton or Waterways, railway points, takes but three and a half days. The airplane has to a large extent made possible the rapid development of this new mining region.

Radium from the Arctic dates back but a few years, to the beginning of the decade, when two prospectors struggled against blizzards, snowblindness, and an inhospitable country to reach an island in Great Bear Lake on which they had noted a peculiar mineral formation the previous summer while flying over the region, southward bound.

On the shores of Great Bear Lake men are busy, winter and summer, taking from the earth tons of rock rich in silver and radium content. Tunnels have been dug in what a few years ago was an unknown and isolated wilderness, passed through by perhaps a few trappers and a few Indians. Now there are mine railways, ore compressors, workshops, log cabins, stores, airports, and radio stations. Now the lake in summer has the traffic of a variety of boats, while planes land and take off from its sometimes turbulent waters. There, on the shores of Great Bear Lake, the bags of ore are filled, ready for shipment south.

At Port Hope a new method has been developed which cuts the time of extraction from the rough ore to three months.

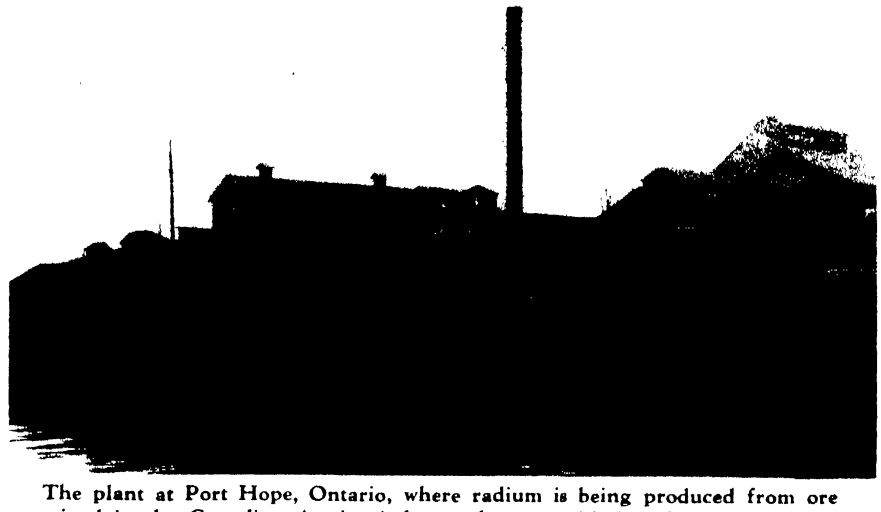
A plane on skis, with freight, at Echo Bay, on Great Bear Lake



Pilots who fly the Canadian northland are nowadays prepared for shipwreck on the many lakes of that region. They carry inflatable folding rubber canoes

RADIUM

Gilbert LaBine, discoverer of the ore at Great Bear Lake (on right)



The plant at Port Hope, Ontario, where radium is being produced from ore mined in the Canadian Arctic. A large plant, considering the circumstances

By JAMES MONTAGNES

Radium can be obtained only by chemical treatment requiring many operations. Three tons of chemicals are necessary to procure radium from a ton of ore. With these huge quantities of chemicals the crushed ore is treated. Every resultant solution and residue are handled over and over again, to extract every particle of radium concentrate from it. With every move in the process so carefully checked, weeks go by before pure radium is produced.

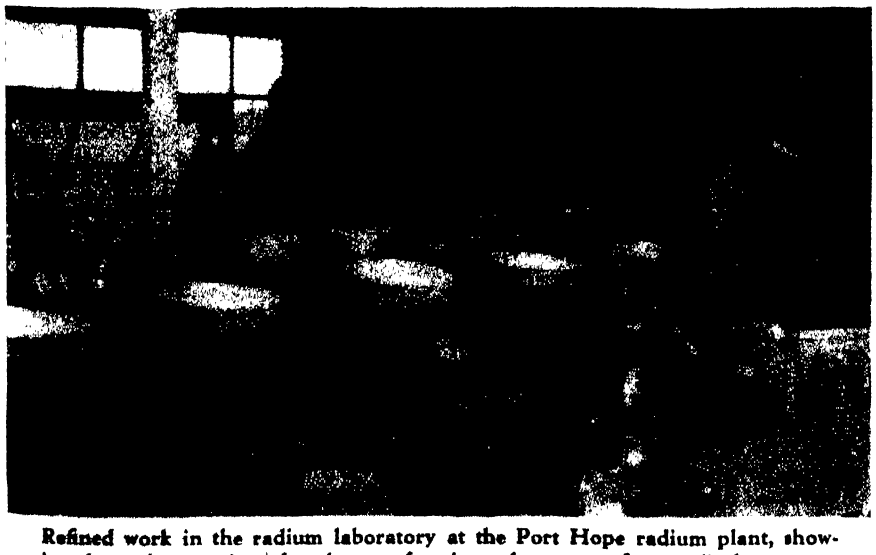
Great care is taken in handling radium bearing ore at the plant, for radium is a dangerous mineral, although it has healing qualities. Even the ore as taken from the mine is likely to damage the skin of any person handling it carelessly or injudiciously.

A finished radium "needle," for use in treating cancer by radium

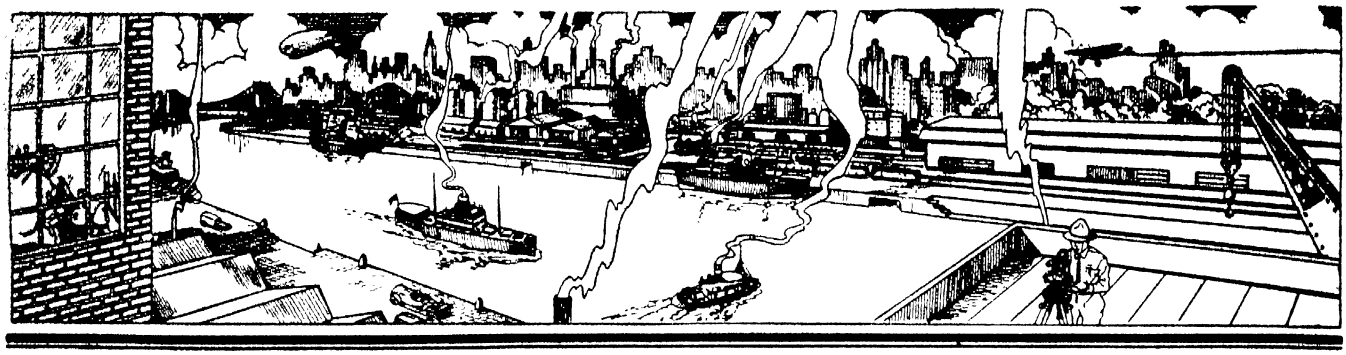
The chemical process of extracting radium from pitchblende develops a number of by-products in the form of salts and minerals of different kinds. These are reclaimed from the various solutions through which the ore is put. Silver, lead, and some minerals used in the paint and pottery trades are thus obtained. Other by-products, such as uranium by-products, are sealed in small glass containers and shipped to recognized laboratories in Canada, the United States, and Europe for certification of radium content.

THE radium plant differs from most mining plants in that it is largely a laboratory, few heavy machines being used, except for the crushing, boiling, and live steam processes. Earthenware jars, glass retorts, and other utensils of the chemical laboratory are mainly in evidence, rather than the bulkier objects one would expect.

Doctors and patients have their eyes on this radium plant. The hopes of many cancer sufferers are centered in this comparatively new industry, for radium treatments are the best cure for cancer ailments discovered up to this time by the medical profession. Only a very small quantity of radium is in use in hospitals—nearly all that is now available. And that small amount is not enough for all the hospitals where cancer sufferers are being treated. The expense and scarcity of the mineral, until recently mined only in the Belgian Congo, have made it possible for only the larger hospitals to have fractional quantities of a gram. A source such as that of the Canadian Arctic is therefore considered of the greatest importance in the medical world.



Refined work in the radium laboratory at the Port Hope radium plant, showing how the ore is reduced to a fraction of a gram for medical purposes



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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Lying-Down Spectacles

"RECUMBENT spectacles"—glasses for invalids and others who have to lie more or less flat on their backs and who wish to read—were shown to the public for the first time at the British Industries Fair, reports *Science Service*. These spectacles

enable the wearer to see more or less at right angles to the ordinary line of sight. They contain a pair of prisms, which project incoming rays of light in such a way that the wearer can read a book held comfortably at arms' length, resting on the waist—in a position where it could not be read at all, ordinarily, without raising the head from the pillow. Corrective lenses for righting defects of eyesight in the usual way can be combined with the two prisms.

Shortage of Coal-Tar Chemicals

A WORLD shortage of important coal-tar chemicals is predicted for the near future by *Industrial and Engineering Chemistry*. The shortage of crude naphthalene is described as acute. Germany has already placed an embargo and indications are that at least one other country abroad will follow suit. Unsettled conditions abroad plus fundamental changes in certain chemical processes aggravate the condition. In the last few years naphthalene has gained an unusually prominent place among intermediates. It is widely used in industry for the manufacture of dyestuffs, explosives, and phthalic anhydride. The latter is a constituent in the manufacture of one of the plastics, the demand for which has grown rapidly, particularly with its inclusion in formulas for protective coatings.

According to the Chemical Division of the Department of Commerce, 4934 metric tons of naphthalene were shipped from Germany to the United States in the first 11 months of 1935, as compared with 8942 tons for the corresponding period of 1934. The domestic demand for naphthalene in Germany has increased to a point where a national shortage is threatened there and as a result the Reich Government has issued a decree prohibiting exportation of crude naphthalene, although refined grades may still be exported under certain circumstances.

The consumption of naphthalene has not appreciably declined for the manufacture of the older products, such as moth balls, and the increase has been for these new uses. During 1934 over 38,000,000 pounds of refined naphthalene were produced in the United States and 48,000,000 pounds of the crude were imported, 22,000,000 of these coming from Germany, 7,300,000 from Belgium, 7,000,000 from the United Kingdom, 5,765,000 from Poland and Danzig, and the balance from Czechoslovakia, the Netherlands, Russia, and Canada.

It is a tribute to the enterprise of our chemical manufacturing industries that there should be a threatened shortage in naphthalene, especially since domestic sources have already developed to the point of furnishing quantities far in excess of all demands that could have been foreseen but a few years ago.—*A. E. B.*

FIFTH AVENUE

JEWELRY, silk stockings, women's dresses, hats, lingerie, cosmetics—many South American women now shop for these things on Fifth Avenue by air.

Japanese Beetles Resisted Winter

COLD weather of the past winter in the area infested by the Japanese beetle—roughly, eastern Pennsylvania and the southern two thirds of New Jersey—seems to have been no hindrance to the grubs that were hibernating in the ground.

Courtesy The White Motor Company

The world's largest strip shovel is shown lifting the world's largest coal truck loaded with 50,000 pounds (total weight 90,000 pounds). This powerful Bucyrus-Erie shovel can move from 2000 to 3000 cubic yards of earth every hour

Recent studies by entomologists of the United States Department of Agriculture show that numbers of this destructive pest in the soil do not decrease in winter, usually the season of heaviest insect mortality. Even the abnormally cold winter of 1933-34 in the east killed comparatively few beetle grubs.

Low temperatures, entomologists explain, stop activities of disease organisms that prey on larvae of the beetle in the soil in warm weather. Furthermore, the larvae, or grubs, of the beetle—the overwintering form—go down so deep into the ground that they are beyond the reach of intense cold.

Japanese beetles in the ground reach greatest numbers early in September at the end of two months of active egg laying. Then they decrease until the weather gets cold. Return of warm weather starts another decrease in the number found in the ground—most striking in May and early June.

New Treatments for Heart Disease

INJECTIONS of alcohol into the nerves beside the spine, removal of the thyroid gland, and a diet of few calories are among the new methods of treating heart disease. These and many others were described by Dr. W. D. Stroud of Philadelphia at a meeting of the American College of Physicians.

Too often the heart is treated for symptoms that are brought on by disturbance of the sympathetic nervous system, Dr. Stroud pointed out. Doctors are finding more and more that prolonged constant anti-syphilitic treatment is of definite value in preventing heart disease due to syphilitic infection.

As yet no vaccine has proved beneficial in arresting rheumatic heart disease, Dr. Stroud said. Digitalis, nitroglycerin, and rest continue to be standbys in treating certain forms of heart disease. For the much-dreaded angina pectoris, Dr. Stroud said that a cheerful outlook, reassurance of the patient as to his condition, and a readjustment of his daily routine with mild sedatives continues to be beneficial.—*Science Service*

New Automatic Train Stop

AN automatic train stop has been perfected by an Austrian engineer named Kofler, which is apparently free from the defects of those now in use, particularly under conditions of ice and snow which put the present contact equipment out of operation. The Kofler train stop, which is characterized by rugged construction, extreme simplicity, low initial cost (said to be about 167 dollars), and low upkeep cost, consists of an arm attached to a signal post. When set at "stop" the arm lowers, engages a tripbar on the locomotive that has direct connection with the wheels and sets in motion the mechanism that brings the locomotive to a stop. The device is illustrated in two accompanying photographs.

The "star gazer" in use

PESTS

TWO billion dollars just about covers the damage done by insect pests in this country each year. This sum is estimated from the known amount—about nine hundred million—of the damage done annually by 34 of the more important insect pests.

Star Gazer

MOST practical of all the gadgets we have seen for locating and learning the constellations is a rather simple one invented by Prof. Walter Bartky of the Department of Astronomy at the University of Chicago. A common flashlight battery and lamp illuminate a motion picture film which may be shifted to any one of the common constellations shown on it, simply by pushing the film through to the desired "frame." The whole "Stellarscope" is then held up to one eye, while the other eye beholds the actual sky. The Stellarscope is then moved about until the images in both eyes coincide, and this automatically picks out the whole constellation far more easily than the familiar old method of "Now follow down from that one, a little bit to the left to a red one; and then over to the next one just above Smith's woodshed; and on down again about to the roof; and then over. . . ." Or, even if large illuminated charts are used, the eye must be shifted back and forth, so that the views are not at first seen as a whole, as with this little device. It deserves the commendation it probably will receive. The University of Chicago is using Stellarscopes in its evening class work exercises.

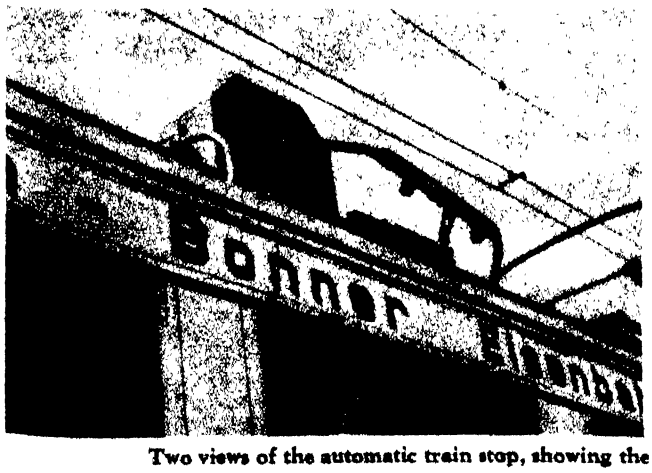
Wood Distillation Comes Back

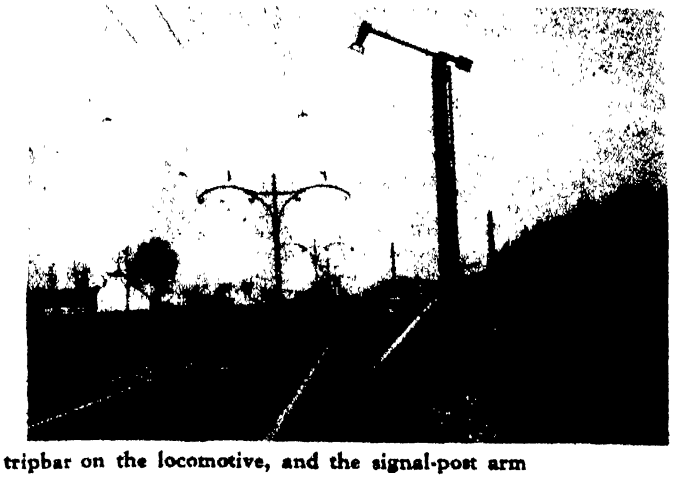
JUST a few years ago we reported in these columns that synthetic methods for the production of acetic acid threatened the life of the wood-distillation industry. The wood-distillers were not willing to give up the ghost so easily, however, and they put research chemists to work with the result that improvements in wood distillation methods have again put acetic acid from this source in a favorable economic position to compete with the synthetic product. By continuous direct separation of acetic acid, wood alcohol, acetone, and tar from the crude pyroligneous acid from the retorts, substantial savings are effected over the now obsolete process involving the intermediate production of calcium acetate. The azeotropic distillation process yields glacial acetic acid directly.—*A. E. B.*

The Electrocamera

PARALLELING recent developments in the photography of lightning discharges, a new technique called "electrophotography" has produced portraits of electrical discharges through insulating materials. The importance of the new development, according to the *Industrial Bulletin* of Arthur D. Little, Inc., is due to the need for better insulators in modern methods of power transmission and use. Moist oil-immersed photographic film or paper is placed in a light-proof housing with the insulating material being examined, then a high-potential alternating current is passed through and a photographic record is made of the location and intensity of the breakdown of the insulator.

Collision of electrons and charged positive ions produces a local corona, says the physicist, but whether he is right or wrong,





Two views of the automatic train stop, showing the tripbar on the locomotive, and the signal-post arm

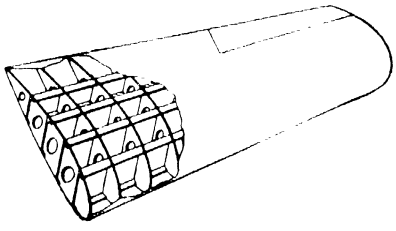
the new method indicates the voltage at which cable destruction will begin, and it may be applied as well to mineral insulating oils, solid insulating materials, the new "superdense" papers and tapes used in cable manufacture, and even impregnating compounds. The very mechanism of electrical breakdown and the factors effecting it may now be studied more effectively, and the modern knowledge of materials brought more successfully to bear on electrical engineers' problems.

Great Circle Aircraft Construction

THE shortest distance between two points on the surface of the earth is on a "great circle." The diameter of a "great circle" is the diameter of the sphere itself. But what has the great circle to do with airplane construction, and why did newspaper announcements of geodetic or great circle construction by Vickers in England arouse such interest?

The most efficient way to build an airplane is to make it a monoplane, and the most efficient way of securing good climb and take-off is to give the monoplane a large aspect ratio, which, in non-technical language, means to give the wing a long span. But when the monoplane wing is long and thin (it should be thin for aerodynamic efficiency) the high bending moments near the fuselage are very hard to meet structurally. The aerodynamic efficiency of the long monoplane wing is counteracted by the high structural weight of the wing.

American designers have been the pioneers in all-metal monoplane wings of large aspect ratio and have designed their structures in a number of different ways. A typical construction is that shown in one of our



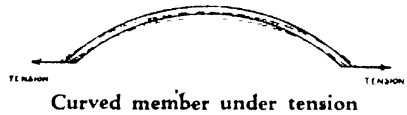
Conventional wing construction

diagrams. The sketch shows a number of rather light spars or longitudinals; at intervals the spars are connected together by rigid bulkheads or ribs; over the ribs and bulkheads there is a metal skin covering riveted to spars and bulkheads; to make the skin of the upper surface of the wing contribute to the strength, this skin is reinforced at intervals with "stringers" (not shown in the sketch).

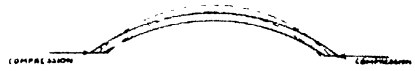
This construction has proved surprisingly effective, but is also very complicated in calculation and, what is worse, is very hard to build. There are thousands of rivets to be placed—driven in, sometimes in the most awkward positions.

B. N. Wallis of the Vickers company has hit on an entirely new method of construction, the geodetic method, which gives promise not only of greater lightness (or, alternatively, the ability to make the wing longer for a given weight) but also of far greater simplicity.

Suppose we have a curved member of metal as shown, to which a tension load is applied. What happens? The member tries to extend and the center portion of the curved member tries to go down. But suppose we have a curved member of metal, to which a compression load is applied. The member tries to compress and the center tries to go up. If the compression member



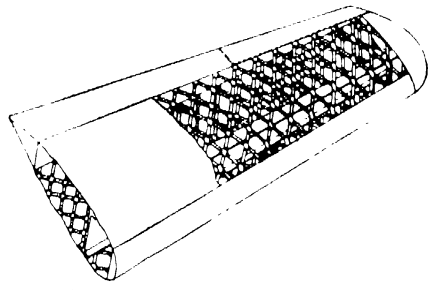
Curved member under tension



Curved member under compression

is thin it will fail very readily. This is the reason why the thin metal cover of the upper surface of a wing has little strength in compression and buckles or crinkles easily.

Now here is Mr. Wallis's brilliant idea: Suppose we connect curved compression members to curved tension members at their centers. The tendency to rise and the tendency to go down at the center points will neutralize and the full strength of the material will be developed. One of the illustrations shows diagrammatically how

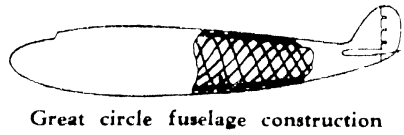


Great circle wing construction

this new and simple principle is applied in the construction of a monoplane wing.

There is still a spar to take up the bending loads, but there is only one such spar. To take up the twist loads, thin strips of metal are wound in contrary directions with a connection between the strips at their intersection points. The whole is covered with very thin sheet. Owing to this neutralization of loads at the intersection points, and the fact that the strips are placed as far as possible from the center line or "neutral axis" of the wing, all the material works in the most efficient possible fashion. These curved strips are "geodetics" or great circle lines—hence the name.

A fuselage built on the same principles



Great circle fuselage construction

is also shown. It certainly is reduced to the simplest form, all other internal members disappear, and a great deal more room is available for baggage, mail, and so on. —*A. K.*

Blind Flying by Sound

IN a recent paper presented before the Institute of Aeronautical Sciences, Luis de Florez, consulting engineer and private plane owner, described some novel experiments demonstrating that blind flying with the ear as a guide is quite possible.

It has long been known that our ears detect the direction of sound through what is known as the "binaural" sense with which virtually everyone is endowed. This directional sense is based on the ability of the brain to interpret differences in phase and volume of sound which occur when sound waves strike the ears unevenly. Thus if a sound be produced to one side, the nearer ear will be struck by the sound waves first as well as in greater volume. When we wish to face the sound we turn the head until the ears receive the sound waves simultaneously and in equal volume. It is upon this principle that Mr. de Florez's experiments are based.

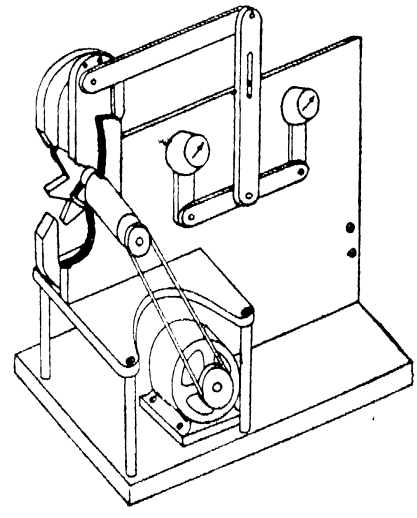
The laboratory experiments were made with very simple apparatus, shown diagrammatically in the sketch. The sound was produced by a six-toothed inductor wheel rotating between the poles of two electromagnets, producing alternating currents in the circuits and setting up a hum in each of a pair of earphones. By varying the speed of rotation, changing the position of one magnet with respect to the other, and manipulating the rheostats, variations in pitch and intensity could be imparted to either ear.

When Mr. de Florez sat in a swivel chair, and someone else operated the apparatus, he found that he could follow the apparent source of the sound all around the room.

The second phase of the experiments was to determine whether the average ear could remember and return to a given pitch. This was done by varying the speed of the wheel and returning it to approximately the same pitch as before such manipulation. It was found that the ear and brain were quite capable of such a task.

The next step was to make experiments in actual flight. The pitch sound was produced by a small wind-driven magneto attached to the flying struts and well out of interference with the wing. If the airplane nosed down and its speed increased, the speed of the windmill would increase also, the acoustic pitch would be higher and the pilot would be "aurally" notified that the nose of his craft was going down. The gyroscopic turn indicator was so connected with the electric circuit that a turn to the right brought the sound to the right ear and vice-versa.

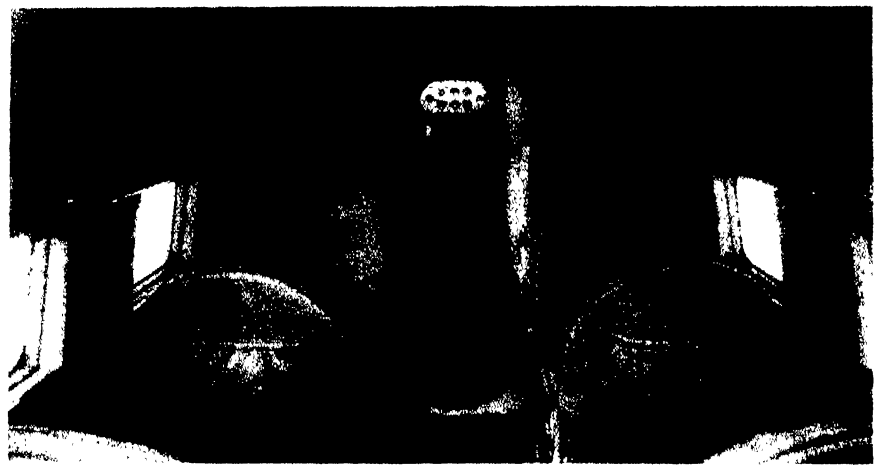
The flight tests were carried out in a two-



Laboratory unit for experiments in blind flying by sound, showing inductor wheel and movable magnet

seater parasol Fairchild 22 equipped with a Warner 145 horsepower engine. Mr. de Florez states that with eyes blindfolded, or in fog, he was able, after relatively little training, to keep a fairly straight course for more than 40 minutes, and carry out turns correctly. After his controlling co-pilot had deliberately put the plane in a spin, he was able to bring the ship back to normal after somewhat more of a dive than usual.

Space will not permit us to go into greater detail. In general, it was found that the acoustic characteristics of the position of flight were interpreted almost subconsciously, perhaps in the same way that dancers follow music without conscious effort. One can readily see what a help it would be to the pilot if in blind flying he received indications subconsciously through his ears while his eyes were free for the many other duties which a pilot has to perform.—*A. K.*



Comfortable interior of the new Fairchild 91 described below

AIR TRADE

THE United States not only leads every country in the world today in air trade with South America, but her yearly trade by air with that continent is greater than that of all other countries of the world combined.

Inside an Amphibian

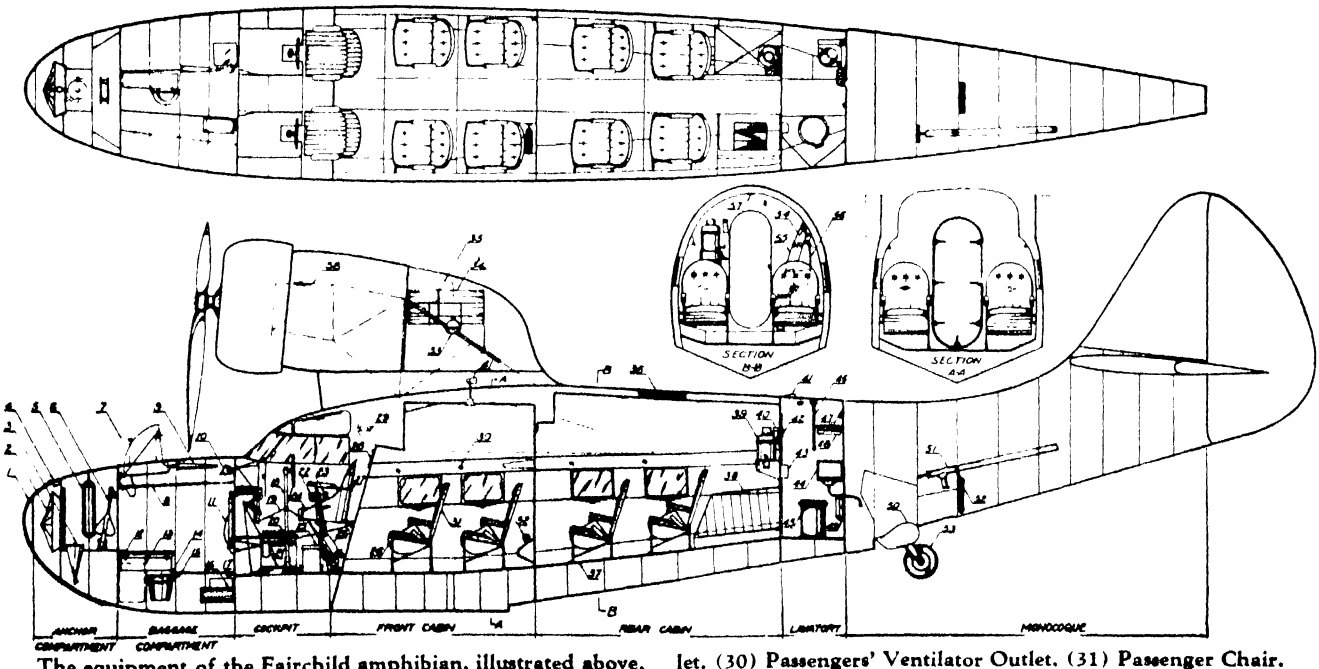
WE never cease to marvel at the complexity of the modern airplane as compared with the stark simplicity of the early stick-wire-fabric contraptions that flew so daringly. The new Fairchild 91, which is said to be the world's fastest and largest single-engined amphibian, is a splendid example of the remarkable equipment that is taken for granted in the passenger aircraft of to-day. Powered with a Pratt & Whitney Hornet of 750 horsepower, it has a top speed of 173 miles per hour and a useful load of 3904 pounds (crew, radio, fuel, oil, passengers, mail, and express). The gross weight is 10,500 pounds, which means that the useful load is about 40 percent of the gross weight—somewhat of an achievement.

The new craft is to be put in service by Pan American Airways on a 1000-mile stretch of the Amazon River, between Para and Manaos, reducing the run from 10 to 6½ hours, and bringing Manaos, in the wilds of the Brazilian jungle, to within four days' travel by air from New York City.

Our photograph shows an interior view of the cabin. The 16-foot cabin is divided into two compartments, each fitted with four reclining seats which are set in rubber. A bulkhead is inserted between the two passenger compartments. There is a large individual window at each seat, and individual nozzle-type ventilation controls. The sound level is low, thanks to scientific soundproofing and because the wing is placed between the engine and the cabin, with the engine well forward. The diagrams supplied by the Fairchild company indicate 58 items in the equipment and installation. What troubles the aircraft designer must have in combining all this equipment with structure, aerodynamics, performance, power plant installation, and other problems! —*A. K.*

Airship Survey Report

ALL airship disasters are probed by investigating committees, and all the committees recommend in their reports that



The equipment of the Fairchild amphibian, illustrated above, is as follows: (1) Tow Line. (2) Sea Anchor. (3) Oil Dispenser for Sea Anchor. (4) Mooring Post, retractable. (5) Utility Line. (6) Anchor. (7) Propeller Guard. (8) Boat Hook. (9) Fog Horn. (10) Bell. (11) High Pressure Pump. (12) Tool Box. (13) Engine and Propeller Covers. (14) Bucket. (15) Baggage Hold-down Rings. (16) Sealed Tool Container. (17) Special Airplane Tools. (18) Dual Control Column. (19) Control Column Lock. (20) Very Pistol. (21) Hand Fire Extinguisher. (22) Axe. (23) Machete. (24) First Aid Kit. (25) Battery. (26) Life Preservers. (27) Pilots' Seat. (28) Log Book Container. (29) Pilots' Ventilator Outlet. (30) Passengers' Ventilator Outlet. (31) Passenger Chair. (32) Hand Fire Extinguisher. (33) Water Container. (34) Life Raft. (35) Life Preserver. (36) Soundproofing and Interior Trim. (37) Cabin Floor. (38) Baggage Rack. (39) Water Jug. (40) Cup Holder. (41) Lavatory Ventilator. (42) Mirror. (43) Tissue Dispenser. (44) Wash Basin. (45) Chemical Dry Toilet. (46) Head Protector. (47) Deodorizer. (48) Paper Towel Dispenser. (49) Waste Receptacle. (50) Retractable Water Rudder. (51) Bilge Pump. (52) Hoisting Sling. (53) Retractable Tail Wheel. (54) First Aid Kit. (55) Entrance Ladder, interior fixed. (56) Entrance Ladder, outside retractable. (57) Dome Light. (58) Engine Nacelle.

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Another type of rail-highway truck that makes possible store-door delivery of freight. The flanged wheels are so arranged mechanically that they can be lowered to the rails, or raised out of the way for highway travel, in a very short time

more airships should be built. The arguments offered are now almost classical—that there are disasters in other fields of transportation as well, that the safety record of small airships is remarkable, that the military or naval value of the airship is well established, and so on. The conclusions of the recent Airship Survey Committee Report and its general character are closely reminiscent of a series of articles on airship safety which appeared in the columns of Scientific American early in 1925!

The Committee suggests, however, that the next large airship to be built for the Navy should not be intended for actual service with the fleet, but should constitute an experiment on scientific lines. That is probably the very best way of really settling the question once and for all.

The Committee recommends that the airship be designed in the light of the most recent studies and advances in structure, aerodynamic theory of the loads imposed, and meteorological science, particularly as regards gusts.

When completed the ship would be used as a giant laboratory. The constructors, in co-operation with the Navy Department, would take strain gage readings at all critical points, and make other careful technical observations under progressively more severe operating conditions. The personnel would be specially trained in weather study.

With the construction of the ship undertaken as a scientific experiment and with no false expectations aroused in the minds of the public, the Navy certainly would be in a "safer" position to undertake the building of another airship.—*A. K.*

Marine Grass Cutter

If you've ever had to pole a boat through a heavy growth of seaweed or underwater plants of any kind; if you've ever had to clear a weed-fouled propeller; if the channel to your boathouse is so weed-choked that you—but let's omit the profanity and examine a new weed cutter developed by Electri-Craft Corporation.

As shown in the illustrations, this device consists of a circular saw which operates in a horizontal plane at the lower end of a shaft clamped to the stern of a row-boat. The cutter blade is between two plates which have periodic notches to "back up" the plants being cut. The blade is protected by a vertical guard ring; and the shaft is hinged so that when this ring hits a stone or snag, the entire mechanism swings up.

For power, this device depends upon a storage battery, the motor being built into the top of the shaft. In full cutting operation, the motor draws an average of 14 amperes.

Rubber for Caulking Masonry

An adhesive and caulking material for the building trades, called "Plasoleum," has been announced by the Revertex Corp. of America. The base of the new product is concentrated rubber latex which gives it the water-proofing qualities of rubber as well as its durability and resistance to temperature change. Plasoleum can be spread with a trowel in cold form. Combined with certain fillers, it makes an advantageous material as a filler for expansion joints in buildings and as a caulking material for window frames and the like. Other special uses include its adaptation as an adhesive for laying wood and wood block, linoleum, rubber, cork, and tile on concrete or steel, and for laying linoleum, wainscoting, tile, rubber, and glass on concrete, wood, brick, and plaster walls.—*A. E. B.*

TRANSPLANTED HEARTS

The chicken heart which has been living for years without a body had better look to its laurels. Now comes news of hearts of animals that were transplanted to the bodies of other animals and kept beating as long as the "adopted" bodies lived. These experiments were carried out on lowly animals: red-spotted newts.

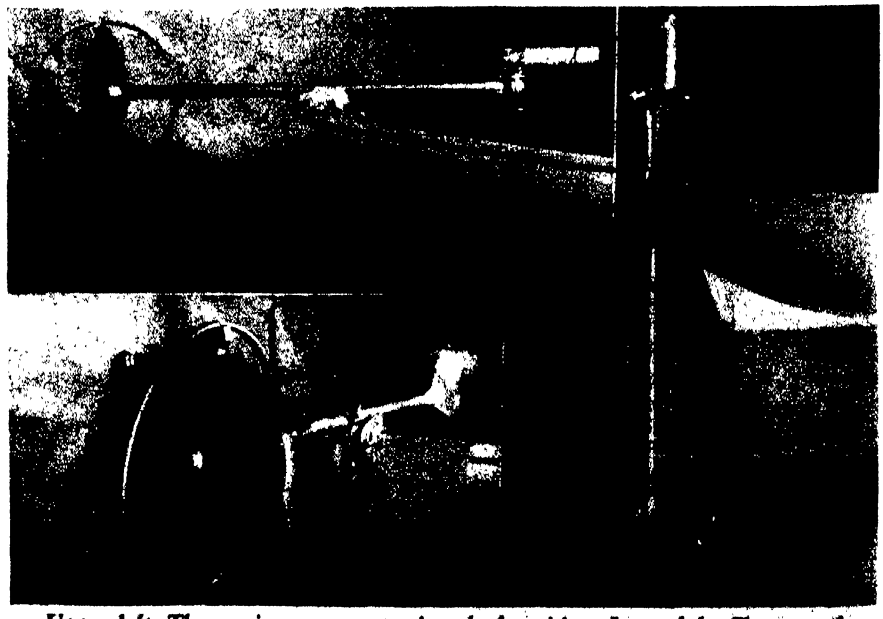
Dust Control

The recent furore concerning alleged deaths from silicosis at Gauley Bridge, West Virginia, has increased the demands for a better dust respirator which workmen may use when exposed to the dangerous quartz and silica dust. Says Dr. Philip Drinker of Harvard University, who is the inventor of the artificial "lung" known as the Drinker respirator:

"Some firms, driven panicky by the present silicosis-dust racket, have even gone so far as to stock up with 'approved' respirators so that they might be able to show they have on hand the best respirators made in case they find themselves defending a dust-compensation lawsuit."

In a report to the American Society of Mechanical Engineers and just published in *Mechanical Engineering*, Dr. Drinker further points out:

"It can be said of all the mechanical-filter-type of dust respirators that they are a poor substitute for dust control. Ultimately it is not an economy to supply workmen with air-line respirators or with dust respirators instead of installing the proper dust-control equipment. Further, the time is not far off when the courts and compensation



***Upper left:* The marine grass cutter in raised position. *Lower left:* Close-up of the weed-cutting disk and guard ring. *Right:* The cutter in operating position**

boards will make short shrift of the employer who lets his men work in dense clouds of dust, regardless of what the dust is.

"In general, the employer would do well to try some of the dusty jobs himself, wear the men's respirators, and thus decide whether or not it would be better to install dust control instead of respirators. However, dust respirators are centuries old; they have a legitimate place in industry, and are an important aid in the prevention of dust inhalation, but they are not a substitute for dust prevention and never should be used as such."—*Science Service.*

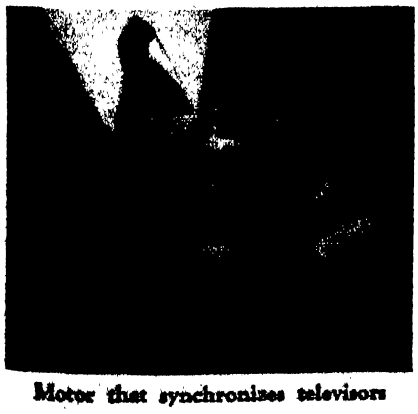
Motor Synchronises with All Television Transmission

NO matter whether a television transmitter is sending 30-line images at the rate of 15 per second or 343-line pictures, interlaced, at 60 per second, they will be automatically synchronized by a new receiver scanning mechanism now being used in the laboratories of the Peck Television Corporation. The secret of this mechanism is a new multi-speed synchronous motor, developed by William Hoyt Peck, to run at a rate governed entirely by the incoming signal.

This motor is but slightly larger than those commonly used in electric clocks, measuring only four inches in diameter and two-and-a-half inches in length, and operates upon much the same principle. The rotor, two inches across and a half-inch thick, rotates between six stationary pole pieces, the windings of which are connected in pairs. The power to energize these windings is drawn from a single stage push-pull audio amplifier, connected in shunt with the amplifier which controls the light modulation. Each frame impulse and each line impulse thus acts upon the field windings of the motor just as the 60-cycle impulses control the ordinary synchronous motor.

Two pairs of the field windings of the multi-speed synchronous motor are connected directly across the output of the power amplifier, the third pair being connected back to the input, so that the current generated in them by the movement of the rotor is fed back in, to intensify the power output. The frequency of this regenerated impulse is, of course, governed by the rate of rotation, so that synchronism is maintained.

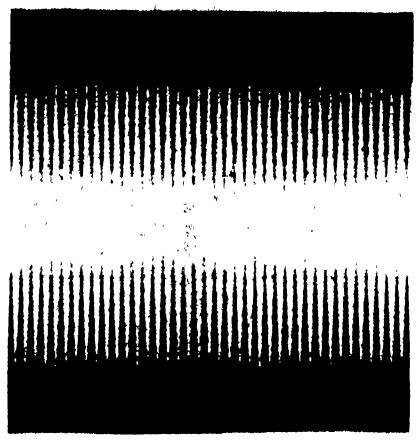
When run directly from 60-cycle A. C., the motor turns at a speed of only 150 revolutions per minute, but when various signals from audio- or radio-frequency oscillators are fed into the amplifier, its speed has been increased up to 28,000 revolutions per minute—well in excess of the 25,725 revolutions per minute necessary for scanning the most detailed picture as yet contemplated by any television concern.



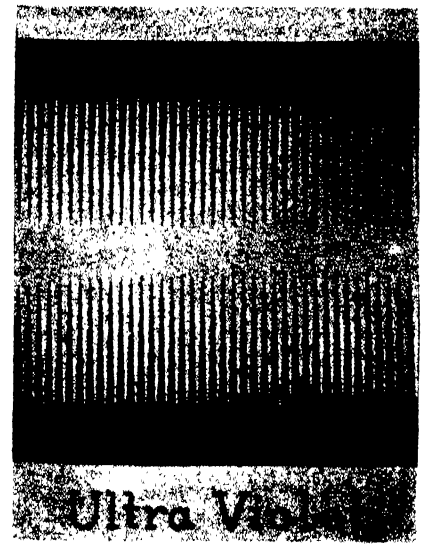
Motor that synchronizes televisors

Sound Recorded by Ultra-Violet

THE lisping and hissing effects which have marred the screen voices of many talking picture stars have been completely eliminated, and the quality of musical reproduction immensely improved, by means of a new sound recording and printing method which utilizes ultra-violet light, in a narrow range above visibility, instead of ordinary white light.



White Light



Compare photographic quality of these sound records as recorded on film by white and ultra-violet light

Recording with the new ultra-violet system is a good deal like improving the details of a photograph. In this case the photograph is the picture of the sound on the film. Acknowledging some earlier research along similar lines by Carl Louis Oswald, the RCA Photophone engineers, working in the research laboratories of the Radio Corporation of America, discovered that by restricting the light focused on the film negative, during recording, to a narrow band in the ultra-violet range, sharper focusing of the lenses in the optical system and controlled penetration of the light on the negative emulsion made it possible to photograph the sound patterns with a sharpness and delineation which corresponds more closely to the characteristics of the original sound than ever before.

The tendency for the high-pitched voices of some screen celebrities to sound sharp-edged, especially in the sibilants, has long presented a difficult problem to motion picture sound engineers. The technical reason for these harsh sounding effects is that by ordinary recording and printing methods the finely graded variations in amplitude of which the upper frequency tones are composed become blurred or distorted on the sound track, so that instead of an exact pattern of the speech characteristics there is merely an approximation. The upper frequencies are the tones which make possible realistic reproduction.

When a high-pitched voice, recorded by visible light, reaches the neighborhood of 9000 cycles, it is necessary to cut off the top range of frequencies or depend on extremely critical and laborious printing of the final track to remove the objectionable rasping effects. The new ultra-violet method is said to give such a sharp and clear definition of the peaks and valleys of the high-frequency waves that there are now no practicable limitations in recording and reproducing all the frequencies necessary for faithful reproduction from film.

CHESTNUTS

SINCE the fungus which has destroyed most American chestnut trees originally came from the Orient, it is interesting to note that Oriental chestnut trees are now being planted in Virginia to see whether they are resistant to the blight. The destruction of our chestnuts was a major blow to American forest industries, for the chestnut is a tree of many uses.

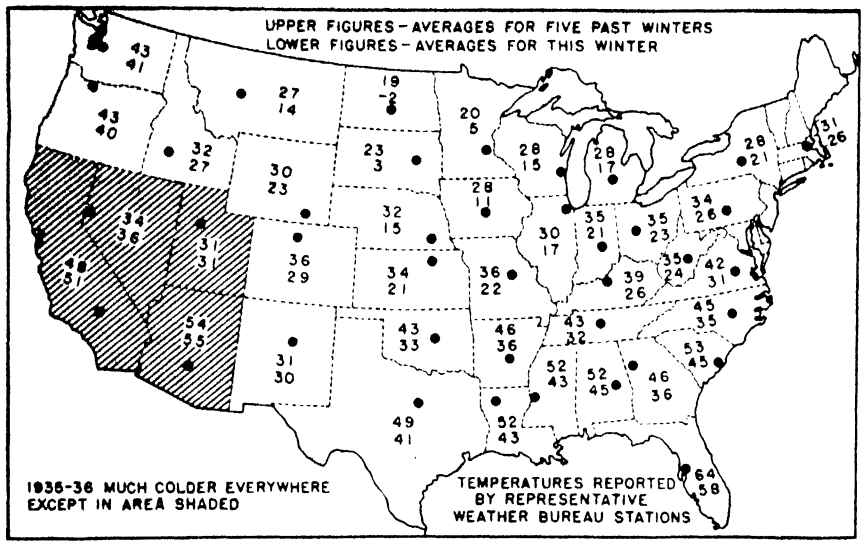
Bad News for Unlucky Parents

IF parents have one malformed baby, are later children born to them likely to be defective too? Physicians are asked this question so many times that one of them, Dr. Douglas P. Murphy of Philadelphia, has made a study of 275 Philadelphia families known to have possessed a congenitally malformed or defective child.

What he found is reported in *The Journal of the American Medical Association.* Dr. Murphy concludes from his study that offspring with serious congenital malformations are approximately 24 times as likely to occur in families possessing a congenitally malformed child as in the population at large.—*Science Service.*

Robot Chemist Detects Gas Danger

A MACHINE that does the work of an analytical chemist was described recently by Murray D. Smith, of the Davis Emergency Equipment Company. The instrument is known as the J-W Combustible Gas Alarm and when installed in a factory, paint shop, or other similar location, it con-



Was the winter of '35-'36 colder than previous winters? This comprehensive United States Department of Agriculture map tells the whole story at a glance

tinuously analyzes the air at any desired point. If, at any time, the air contains a dangerous amount of inflammable gas, the device sounds an alarm, and may also, if so arranged, shut down machinery or start up a ventilating system.—*A. E. B.*

Catapulting Commercial Airplanes

WRITING in the *News Letter* of the Aero Insurance Underwriters, Jerome Lederer advocates catapults for use with commercial airplanes.

An important factor in the finances of air transport operation is, of course, the pay-load for a given horsepower. But increasing the pay-load means increasing the gross weight, and that means a longer and more difficult take-off. Why not use catapults, therefore, to increase the permissible pay-load?

The catapult would have to be designed so as to give a uniform acceleration not greater than the acceleration due to gravity in a falling body. Otherwise the passengers would complain of discomfort. Also, the catapult would have to bring the airplane up to a speed *above* the minimum flying speed, as otherwise the ship would be in very poor control at the instant of leaving the launching device. Another precaution would be the use of powerful flaps so that if the heavily loaded ship "lost" its engines after being catapulted it would not land at too great a speed.

The technical problems in the design of catapults have been solved in naval work, and these devices have also been used on ocean liners for launching mail carriers. With passengers on board the design would have to be worked out more carefully, but the project is undoubtedly feasible. It will be interesting to see whether operators of airlines will give the idea consideration. —*A. K.*

Sun-Spots and Magnetic Storms

PROBABLY the most fascinating characteristic of sun-spots is that of rapid change. Some show changes from week to week, some from day to day, and in some cases the appearance changes even from one minute to the next. And it is only natural that, from the very first, men have tried to connect these changes with occurrences upon the earth. Attempts have been made to correlate sun-spot activity with a large number of variable phenomena—such as rainfall, earthquakes, the price of wheat, and so forth—without reaching any conclusions that have been generally accepted. In fact, of all the influences which sun-spots have been suspected of having upon the earth, only one is so definite that the connection is unquestioned. It is the relationship between sun-spot activity and disturbances of the earth's magnetic field.

Many theories ascribe the origin of the magnetic storm to something propagated from the sun to the earth, such as a stream of electrified particles expelled from a sun-spot, or ultra-violet radiation, but so far no theory has been proposed which adequately explains all the observed facts.—*Dr. R. S. Richardson of the Mt. Wilson Observatory, in "Leaflet 84," the Astronomical Society of the Pacific.*

SPONGE

MAN has never been able to make a sponge comparable with the natural ocean sponge—until now. One recently developed is made of pure cellulose, is a tough compact material when dry, but a soft sponge, comparable with the ocean variety when wet.

Showers Before Swimming Not Enough

SHOWER baths required before swimmers are allowed to enter pools are not enough to prevent the spread of the streptococcus infections of nose and throat, which so commonly develop among those who use pools regularly, W. B. Ardrey of the Michigan State College recently reported to the Society of Bacteriologists, Pathologists and Allied Workers, according to *Science Service.*

Mr. Ardrey found that, when examinations were made of the skin at various parts of the body, streptococci were found in very small numbers except on the hands, and that when swabs were made of the mouth and nose, tremendous numbers of these "germs" were discovered.

Bathers were instructed to take their usual baths before entering the pools and then to stay at the shallow end of the pool and wade around. Few or no streptococci were found in the water until the bathers were told to swim and take exercises which placed their mouths and noses under water. Bacterial counts then made of the swimming pool water showed large increases in streptococci. This was explained on the basis that some water enters the nose and mouth and is immediately blown out again.

Second Highest Dam Built in France

FRENCH engineering skill recently completed the second highest dam in the world—the Sautet Dam at the headwaters of the Rhone River in the French Alps. The structure, a thin wall of concrete 414 feet high, blocks the narrow canyon of the Drac River.

Though second to Boulder Dam in height, it is by far the highest in the world to be built upon tricky limestone, according to *Science Service.* As at the Tennessee Valley Authority's Norris Dam in this country, extreme precautions have been taken to fill the caves and hollows through which water might leak around the dam. Hundreds of holes were drilled into the limestone near the structure—their combined depths total 20,000 feet—and 3000 tons of cement were pumped into them under pressure as great as 500 pounds per square inch.

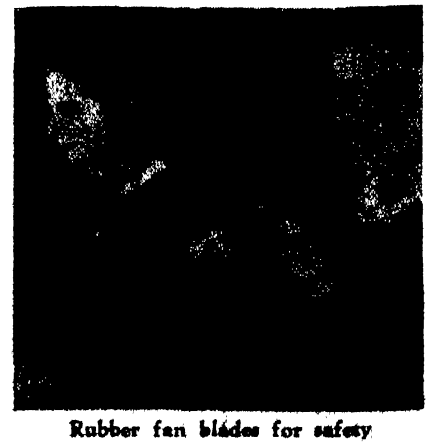
Engineers were spurred to conquer extreme difficulties in building Sautet Dam because the structure will store water until needed by several power plants downstream. It is also similar to Norris Dam in this respect.

Sautet's power plant is wedged into the bottom of the narrow canyon. Indeed, the space there is so narrow that the plant's six 13,000 horsepower generating units are controlled by cables from the top of the dam.

Safe Electric Fan

WHAT seems to be about the most sensible development in electric fan design and construction has been announced by Samson United Corporation, electrical appliance manufacturers.

It is claimed to be the only fan ever built that is really safe! The reason for its inability to cause injury to even the most careless person lies in its new, flexible blades



Rubber fan blades for safety

of tough, molded rubber. These blades, though rigid enough to deliver a steady current of air strongly, are sufficiently soft to prevent injury to even a child's fingers. Thus the necessity for unsightly and cumbersome guards is eliminated.

GLASS PAPER

THE Editor recently received from the Owens-Illinois Glass Company a letter on a tough letterhead which feels like damp parchment. We learned that it is made with glass fibers slightly impregnated with a small amount of rubber as a binder.

Motor Runs on Fuel of Its Own Making

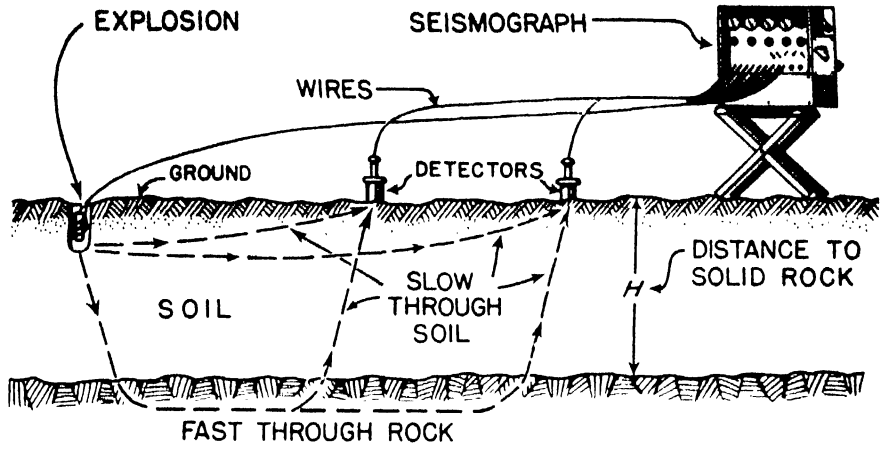
OPERATING on methane gas derived from a sewage disposal process which in turn is activated by the engine, the Ford V-8 motor shown in our illustration has achieved something faintly resembling perpetual motion. The engine is in regular daily use at the Greencastle, Indiana, sewage disposal plant.

The V-8 engine serves two functions in the plant. Power from the engine drives an air blower supplying oxygen to the aeration basin where bacteria are propagated. Further, heat from the engine's cooling system is used to keep the septic tank at a temperature favorable to bacterial action. Under the conditions thus induced, the bacteria become active, resulting incidentally in the formation of the methane gas. The gas, in turn, is piped to the air intake of the engine where it is diffused with air before it enters the motor.

Motor set-up that runs on sewer gas which it helps to manufacture

The engine has been in successful operation since March 1, 1935, using the methane gas exclusively as fuel. It runs 24 hours a day, seven days a week, at a speed of 1500 revolutions per minute. Two regular Ford water pumps are used to pump the water nearly a quarter of a mile to the septic tank, through the coils and back to the motor. According to the engineer in charge, only minor repairs have been necessary during a year's operation and the engine is performing as well as when first installed.

The sewage treatment process in use is known as the "activated sludge" system. About 30 sludge gas engine plants have been installed in this country, England, and Germany since 1927. As fuel costs are next to nothing, the plants normally pay for themselves in about a year.



How artificial earthquakes are used to locate underground rocks

AIR TRANSPORT INCREASES

THE air lines started the year in excellent fashion. Passengers carried during January were 44,061 against 28,922 in January of last year. Express pound-miles flown were over 195 million against more than 113 million last year, and the total miles flown were 4,245,199 against 3,231,096 last year.

Sound Waves Locate Underground Rock

BY precise timing of sound waves racing through earth and through earth and rock, engineers of the Bureau of Public Roads have developed practical field methods for determining the distance below the ground surface to solid rock. These engineers have perfected an instrument by which measurements can now be made on the surface with apparatus that will indicate within a few feet how far below the surface rock will be found. Engineers need such information in planning bridges and buildings, estimating cost of grading for highways, and for other purposes. The measuring instrument is a sensitive seismograph. The method saves the time and expense of drilling to find out how deep the rock lies.

Accurate results are obtained by measuring the speed with which an impulse from the explosion of a buried blasting cap or small charge of dynamite travels through the ground. Such an impulse will travel through soil at a speed of 1000 to 6000 feet per second but the speed through rock is 16,000 to 20,000 feet per second. A cap is exploded in the ground and at the same time the electric current exploding the cap causes a record to be made with precise apparatus for measuring time. Special detectors are placed at different distances from the explosion and pick up the impulse as it comes through the ground. The detectors are electrically connected with the time-recording device and the time of travel of the impulse from the explosion can be measured to a small fraction of a second.

When a detector is close to the explosion one impulse coming through the soil is received. At a greater distance an impulse coming through soil is received and a second one moving down through soil to rock, through rock, and from the rock up to the surface arrives a fraction of a second later. At still greater distances the impulse moving through soil and rock arrives ahead of the impulse moving more slowly through soil alone. Knowing the speed of travel through soil and through rock and the time of travel through different distances it is possible to calculate how far the impulse went downward through soil before it encountered rock.

This method has been used extensively in prospecting at considerable depth for oil. Elaborate and costly apparatus has been used. The Bureau of Public Roads has now developed simplified apparatus that is giving excellent results.

Iodized Wrappers Preserve Fruit

IODINE, the old reliable of the first-aid kit, is a useful medicine for fruit too, according to *Food Industries*. Experiments by the Food Investigation Board of the Department of Scientific and Industrial Research in Great Britain have established the interesting fact that when paper wrappers for certain kinds of fruit are treated with iodine, fungal rotting is greatly retarded. The appearance and flavor of the product is unimpaired. Bunches of grapes wrapped in iodized paper were found to remain free from mold much longer than those wrapped in plain paper. The same applies to tomatoes and oranges. The iodized wraps also reduce the brown rot of plums and peaches, but certain varieties of these fruits were adversely affected by the treatment, failing to ripen properly and even turning black.—*A. E. B.*

Rickets Prevention

A PROTEIN substance found in milk and called lactalbumin helps in the prevention of rickets, according to Dr. James A. Tobey, reports *Science Service*. The lactalbumin apparently does not have any rickets-preventing effect by itself, but when vitamin D is added to milk by irradiation with ultraviolet light, the dispersed lactalbumin increases the effectiveness of the vitamin's rickets-preventing power, Dr. Tobey explained.

The discovery of the rôle of lactalbumin

in augmenting the rickets-preventing potency of vitamin D in irradiated milk was made by Dr. George C. Supplee at the Borden research laboratories at Bainbridge, New York.

Speeds in Sky: Glides On Land

COL. ROSCOE TURNER, one of America's outstanding speed pilots and winner of many trophies for trans-continental airplane records, is "going places" on land, as well as in the air, these days. In his plane, in which he has often crossed the continent between dawn and twilight, he carries a novel vehicle, which was built especially for

Col. Turner and his "motor glide"

him and which is known as a "motor glide." When he lands at an airport, often some miles from the nearest city, he climbs on his motor glide and speeds away. On the streamline tires of his motor glide, he travels five miles at a fuel cost of one cent.

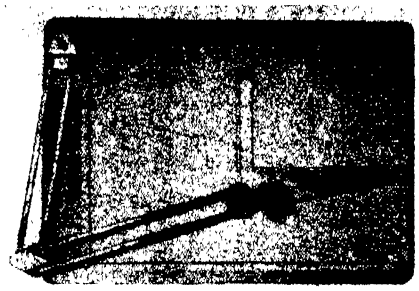
Mystery Springs In North Australia

FIFTY miles south-east of Boulia township, in the far west of Queensland, are two mystery springs. One, known as Elizabeth Spring, consists of a circular hole four or five feet in diameter in which tepid water is continually bubbling up and overflowing. The water, which is perfectly clear, is peculiar in that the human body cannot sink in it owing solely to the force of the water bubbling up from below. About 50 yards away is another called Lubra Spring. Its water is always icy cold and is jet black. The human body sinks like a stone in it. According to the aborigines of the locality, the water in this spring turned black ages ago when a lubra (native woman) jumped into it and was never seen again.—*Australian Press Bureau.*

Professional Drafting Board

A DRAFTING MACHINE to catch the eye of any engineer is the new Wrigraph professional model, shown in the illustration, manufactured by L. G. Wright, Inc.

It is a newly designed drafting machine



A versatile drafting machine

mounted on a 22-inch by 30-inch cleated, white pine board. The parallel mechanism is hand-assembled with all-steel nickel-plated parts and solid phosphor-bronze bearings. This machine is equipped with a vernier-indicating protractor reading to degrees. The protractor unit has a chuck plate to hold the drawing attachments in alignment. The graduated L-square blade is made of Pyroxylin and is riveted to a lightweight aluminum stiffener which has been given a satin finish to eliminate glare. The drawing edges of this blade are transparent.

UREA

THE first organic substance to be made synthetically was urea. Wöhler, a German chemist, produced urea accidentally in 1828.

War Fire

FOGS of fire sprayed from low flying airplanes may be among the new horrors which the next war will bring to civilian populations far behind the actual combat lines, suggests Lieut.-Col. A. M. Prentiss of the Chemical Warfare Service.

Fire, spread by incendiary bombs, shells, and flame throwers, is not dead as a war measure, says this expert, despite the relatively ineffectual success of incendiary techniques in the World War. The rise of aviation since the war is the reason.

While the actual battle forces have become so mechanized that there is little about them to burn but their clothing, the civilians behind the lines will feel the brunt of the warfare by fire.

Writing in *The Military Engineer*, publication of the Society of American Military Engineers, Colonel Prentiss traces the history of fire-making devices in warfare from the first "flame-thrower" used at Delium in 424 B.C., through the famous "Greek fire" of 660 A.D., down to the World War.

Of all incendiary agents used in the World War, thermit was probably most widely employed, he states. Thermit is a mixture of metallic oxide and aluminum which react with an enormous liberation of heat. In fact, it is used in the welding of metals.

For warfare use, thermit was often mixed with a flame-sustaining material. One of the most potent such devices was the British "Baby Incendiary" bomb.

Flame projectors, among the most spectacular of all wartime incendiary devices, not only throw flame, Col. Prentiss points out, but, more important, streams of ignited liquid. Due to research during the war it was finally possible to shoot a stream of liquid which was 30 percent unburned when it reached its objective. There it could spatter and spread its damage. A jet containing a half gallon could be thrown nearly 100 feet with some forms of the equipment. —*Science Service.*

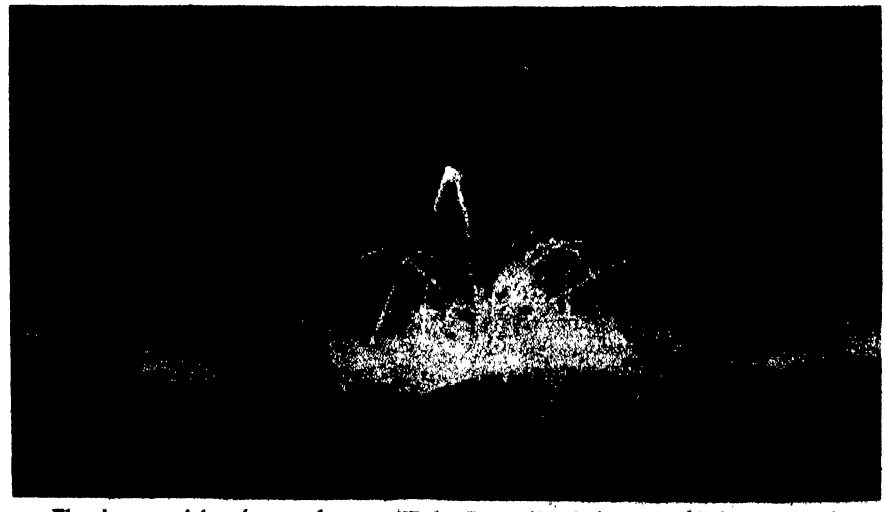
National Noise Standard

RELIABLE standards for the guidance of the 5,000,000 men and women who need mechanical aids to hearing will result from the work of a new committee of the American Standards Association. Headed by Dr. Vern O. Knudsen of the University of California at Los Angeles, a group of manufacturers, specialists, and users will develop national standards for measuring noise so that physicians and the deaf can select devices to aid hearing with scientific guidance.—*Science Service.*

British "Speaking Clock" for Telling Time Over Telephone

A SPEAKING clock being used by the British Post Office department to tell time over the telephone announces the time automatically every 10 seconds, day and night, with an accuracy of one tenth of a second. Each hour the system is checked against the astronomical clocks at Greenwich Observatory.

The telephone time announcements run: "At the third stroke it will be eleven seventeen and forty seconds." The spoken words are followed by three "peep" signals of 800-



Flaming particles thrown from a "Baby Incendiary" bomb exploding at night

cycle tone, at one second intervals and lasting one tenth of a second.

Four glass disks, carrying sound tracks photographically recorded, make the announcement. One disk, turning 60 times each minute, carries records of the odd numbers 1 to 59, and a second disk the numbers 2 to 58, together with the word "o'clock." A third disk speaks the hour and carries also the phrase "it will be." The fourth disk makes the preliminary announcement "At the third stroke" and adds the final part of the speech "and ten seconds."

Optical systems and photoelectric cells turn the disk records into electric current.—*Science Service.*

Anti-Friction Molding Material

WHILE standard phenolic molding compounds are fairly resistant to friction, there are applications where constant friction, plus impacts of varying degrees, require material of greater resistance, such as cam parts, automobile door bumper shoes, builders' hardware parts, refrigerator latch bolts, machine parts in constant friction, and so on. To withstand this friction, General Plastics has developed a new Durez material called "1564," which combines both impact strength and friction resistance. It contains 10 percent graphite, and has an impact strength that is roughly 40 percent greater than ordinary materials. Its most interesting use is the small bumper shoe which bears against the metal wedge on motor-car doors, supporting them and preventing rattling.—*A. E. B.*

Live Bait Fish Threaten to Spoil Fishing

FISHERMEN in Utah's trout streams are threatened with serious damage to their sport because other fishermen make use of live bait. This ironic situation has received the attention of W. F. Carbine, of the University of Utah.

Small fish used as live bait sometimes slip off the hook, and live to grow up and reproduce. Prominent among fish thus introduced is the chub, a species not particularly esteemed for either sport or food. This fish makes life harder for trout in two ways. It produces many more eggs, in the same spawning grounds that the trout frequent. The more numerous and hardy young chub gobble up a great deal of the food that the troutlings would normally have for themselves.

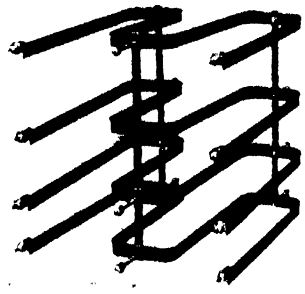
Young trout that survive this period of over-competition for nourishment find that their troubles are not over by any means. As they swim down the streams, the adult chub, which are big fish measuring up to 16 inches in length, pounce on them and gobble them up in numbers. Young chub, on the other hand, are not taken for food to any extent by the adult trout.

To reduce the numbers of this troublesome enemy of the trout, Mr. Carbine suggests forbidding the use of live bait; also netting the chub and lowering of the water level in the lakes which are their favorite waters.—*Science Service.*

Pasteurized Dirt

CLEAN dirt, not an anomaly but a necessity for florists and specialty growers, can be obtained electrically with the use of equipment just developed. The sterilization process, similar to that employed in the pasteurization of milk, has been performed with steam, hot water, and chemicals, but an inexpensive method was needed to make soil sterilization available to a larger number of plant growers and at the same time to afford a process that was convenient and dependable. The function of sterilization is to increase the temperature of the soil sufficiently to kill any plant enemies, such as weed seeds, insect life, and fungi, as it is only when plants are free from these enemies that they can grow at a maximum consistent rate.

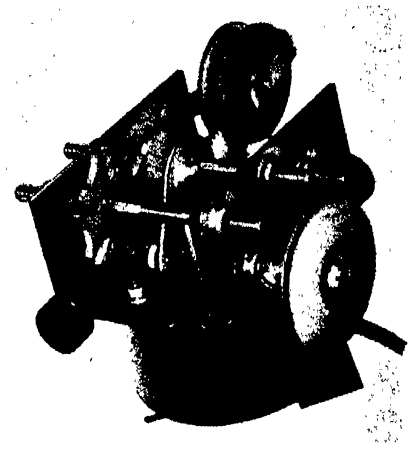
The sterilizing equipment, developed by General Electric, consists of a number of electric heating units, each enclosed in a brass vane, which are provided with mounting straps, studs, nuts, and washers. The grower builds this equipment into a wooden vat or container following plans made to meet his own requirements. A thermostat can be supplied which will maintain automatically the necessary temperature of 160 to 180 degrees, Fahrenheit. Growers have found that the single saving from not having to weed small plants is sufficient to offset the cost of electric sterilizing.



***Above:* An electrical heating unit used for pasteurizing dirt. *Below:* Plants (left) grown in pasteurized dirt, and (right) weed growth in dirt that has not been pasteurized**

Motor of Many Uses

A NEW slow-speed versatile electric motor should be found useful by engineers, chemists, inspectors, and inventors, for it provides an extremely simple, time-saving means of securing the many different speeds and motions required by laboratory and shop testing.



Multi-speed multi-purpose motor

The illustration shows the simple construction of the Testmotor which consists of a slow speed, induction or universal motor, equipped with a cooling fan that circulates air through the motor, permitting its use under extreme heat conditions. The motor is mounted on a heavy steel frame. All shafts are ¼ inch in diameter, in self-lubricating bearings. Each shaft has a thrust washer, so that loads may be taken endwise without excessive wear or special lubrication; a milled flat provides each shaft a positive connection for gears and adapters.

The motor is mounted by rubber grommets that eliminate vibration, insuring silence, or by holes in the frame ears over which these grommets fit. The overall dimensions are 4½ by 4½ by 5 inches and the weight is 3½ pounds.

The shaft motions of the motor are: Fast Rotary—56 R. P. M.; Slow Rotary—6 R. P. M.; Oscillating—70° Movement; Indexing—Stops at 60° intervals for a period of 3 seconds.

For additional speeds, a frame having a gear ratio of 8⅔ to 1 is available.

A few of the many applications of the Testmotor are: With tilting mercury switches, it can be used for all start-stop electrical tests; Life test of electrical switches; Mixing compounds or solutions; Revolving color wheels on spot lights; Display advertising; Turntable for spray painting.

Peanut-Walnut

HAVE you ever had a "peanut-walnut"? So far as is known, there are only two trees in the whole United States which pro-

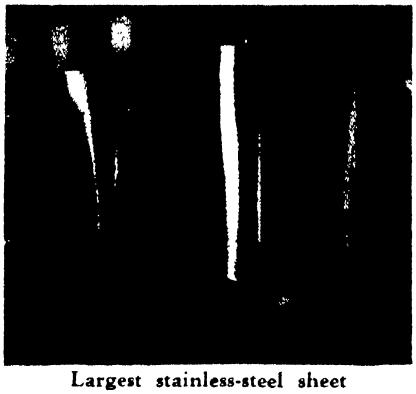
duce this freak form of the common black walnut. One of these trees is somewhere in Ohio; the other grows on the farm of Ralph Throp, near Greensburg, Indiana. From Mr. Throp the department of botany at Field Museum of Natural History has received specimens of the curious peanut-walnuts.

Viewed from the outside there is nothing remarkable about the appearance of peanut-walnuts, but when they are opened the kernel or meat falls out or may easily be removed in a single piece. The kernel is only one half of an ordinary kernel in form, but is larger in size.

The advantages of such a kernel, which can be removed whole, are apparent, and it would be highly desirable to propagate the tree commercially. Grafting experiments, however, have so far been unsuccessful, and, according to Paul C. Standley, associate curator of the museum herbarium, it is questionable whether a freak or sport of this kind would be reproduced in seedlings.

Huge Stainless Sheet

PRODUCTION of what is believed to be the largest, polished, stainless steel sheet yet made, has just been completed by the Allegheny Steel Company. This sheet, one of an order of 15, is slightly over 208 inches long, 72 inches wide, 3/16 of an inch thick, and weighs approximately 810 pounds. According to the records, the largest similar sheet previously produced was 90 by 84 inches.



Largest stainless-steel sheet

These sheets were all furnished with a bright smooth finish and are used in the textile industry, in forming the bottom of dye kettles through which articles being dyed are conveyed.

Bureau of Standards "Visitor's Manual"

THE Bureau of Standards publishes an interesting "Visitor's Manual" (Misc. Publ., M153), giving a brief synopsis of its history, functions, and facilities, according to the magazine *Nature*. An afternoon visit to certain of the laboratory rooms is arranged every day. It is mentioned that the discovery of deuterium (heavy hydrogen) was the result of co-operative work of the laboratory with Columbia University. The use of the lowest temperature so far attained in the United States—the melting point of liquid helium (–456 degrees Fahrenheit)—has made possible the study of the properties of materials at very low temperatures, in particular the supra-conductivity of metals. The Bureau constructed the first "altitude" laboratory for studying airplane engine performance under flight conditions. In it, the low air pressures and temperatures encountered at altitudes up to 30,000 feet can be duplicated. The Bureau workers were the first to discover that a thin coating of pure aluminum greatly decreases the atmospheric corrosion of duralumin, an alloy largely used in aircraft construction. They worked out the very successful process of plating steel and other metals with chromium, the hardest metal known; this more than trebles the life of gages, printing plates, and similar devices. The Bureau developed the paper now used for printing United States paper currency, which has extended the total service life of such notes at least three times. It discovered that certain waste water from paper mills makes satisfactory material for tanning leather, and it established the dextrose (corn sugar) industry. It keeps the public well informed of its work, and its staff has increased by 50 times since it began in 1903.

Vanilla Paint

CAN you imagine walking into the hardware store and asking for a can of white paint, vanilla flavor? Strange as it sounds, you'll be able to buy just that if a new plan for "killing" the odor of paint is generally adopted. In a statement by Dr Henry A. Gardner, issued by the scientific section of the National Paint, Varnish & Lacquer Association, it is disclosed that ordinary vanillin—one part in 2000 parts of paint—is rated very highly for deodorizing or rather changing the odor of paint to one that is not obnoxious. The vanillin is slightly higher in cost than other types of industrial perfumes. Vanillin may be dissolved in turpentine or linseed oil to make a concentrated base which can be added in the proportion referred to above when treating interior paints.—*A. E. B.*

First All-Metal, Streamlined Milk Tank Car

THE first all-metal, streamlined milk tank railroad car ever built—a giant "thermos bottle" refrigerated so that even in summer milk can be transported 200 miles with a rise of not more than one degree in temperature—was recently "launched" at Hoboken, New Jersey, by H. A. Cronk, President of the Borden's Farm Products division of The Borden Company. The car was immediately placed in service in the New York area.

This giant "thermos bottle" throws additional safeguards around the safety and purity of the milk of city dwellers. All future replacements to the present 60 tank cars the company now operates in the New York metropolitan area will be of the streamlined type.

Fifty percent better refrigeration will be brought about by the use of six inches of cork insulation between the two 12,000-quart, glass-lined tanks in the car and the all-steel outside. Tests indicate that the all-metal construction will result in lower repair and painting costs and much longer service.

The new car is equipped with standard passenger train brakes and trucks, so that it can be coupled to fast passenger trains for speedier milk service from outlying dairy districts to the metropolitan area.

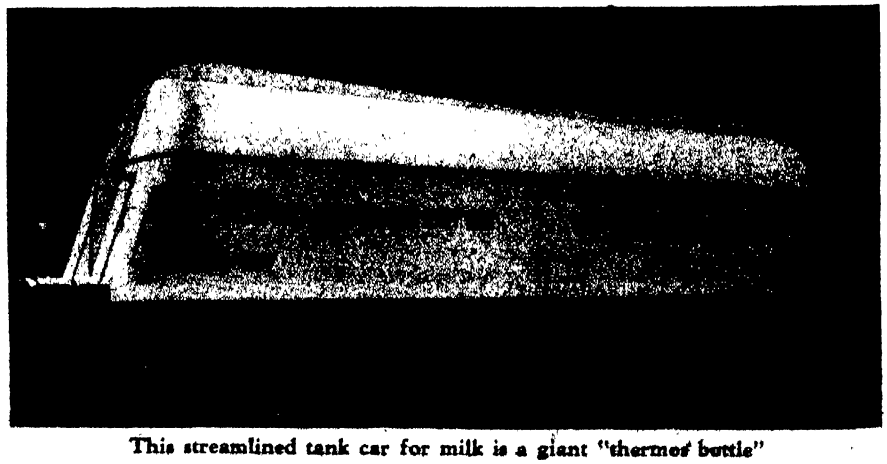
Tiny Glass Tube Put in Blood Vessel

A METHOD of gaining new knowledge on obscure diseases of blood vessels and on the watery swellings known as edema was described by Dr. Eugene M. Landis of the University of Pennsylvania Medical School at a meeting of the American College of Physicians. For the development of this method, which was called the most outstanding piece of medical research in 1935-36, Dr. Landis was awarded the John Phillips Memorial medal of the college, reports *Science Service*.

The method is designed to give information about the state of minute artery endings called capillaries. These are found at the tips of the fingers and toes, in the nail beds, and just under other outer surfaces of the body. In certain conditions like Raynaud's disease, in which the fingers and toes are always cold and an unhealthy white color, physicians know that a disturbance of the blood flow through the capillaries is to blame. Just what the disturbance is and what to do for it are still unsettled questions which are engaging more and more the attention of medical research workers.

The method Dr. Landis devised for investigating the state of these capillaries is to insert a very tiny glass tube called a pipette into a single capillary in the bed of a man's nail or in tissues of other animals. The capillary blood vessels and the glass tube are both so small that Dr. Landis has to work under a microscope.

By this method he has measured the passage of fluid through the walls of normal capillaries into the surrounding tissues. With this as a standard, he measured the

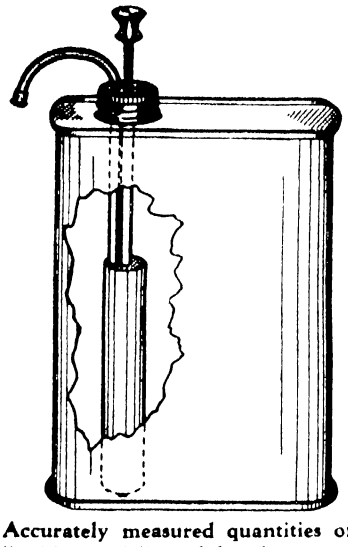


This streamlined tank car for milk is a giant "thermos bottle"

passage of fluid when the capillary walls had been damaged by chemicals or by mechanical injury. He found that the fluid passed through the damaged capillary walls from five to seven times more rapidly than normal. This finding shed light on the condition known as edema in which apparently too much fluid passes through the capillary walls.

Automatic Liquid Measuring Pump

A NEW liquid measuring pump has solved the problem faced by chemists, engineers, druggists, and others who must constantly dispense measured small quan-

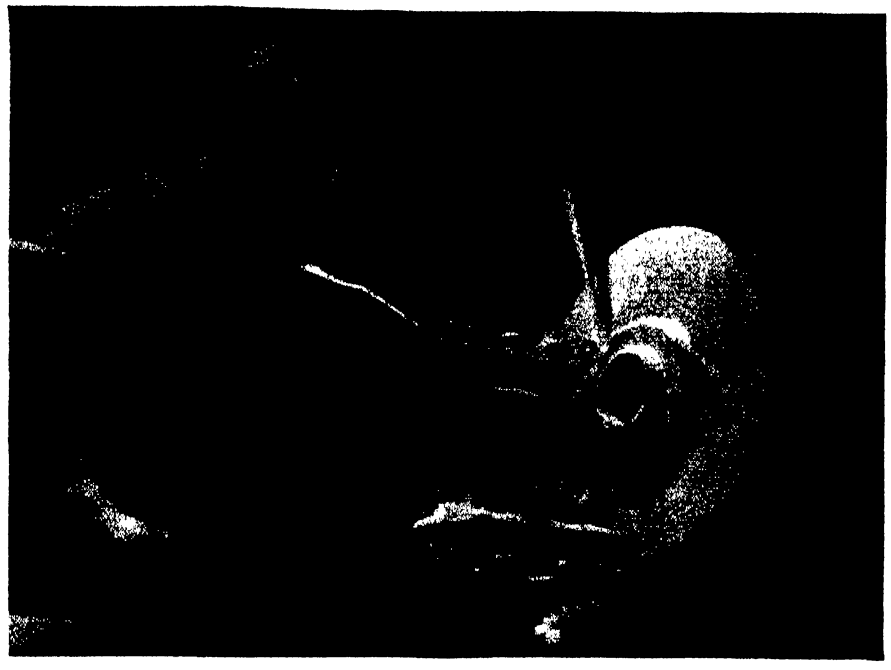


Accurately measured quantities of liquid are delivered by the pump

tities of oils, glycerine, and other liquids. This inexpensive little device is built for use with a standard quart can, or standard gallon can, the first delivering one half ounce of liquid per stroke and the latter one ounce of liquid per stroke. This pump is a convenience to engineers and oilers of pumping stations, power houses, steam boats, and other power machinery, for use in replenishing oil cups.

Underground Pipe "Wrapped in Cellophane"

WE have become accustomed to having almost everything "wrapped in Cellophane," but had to admit the novelty of an application described in a recent issue of *Western Gas*—underground pipe is being wrapped in Cellophane! The wrapping is said to serve admirably as a protective measure against moisture and soil impurities. The theory underlying the use of two layers of Cellophane or Kodapak adjacent to one another, is that a slip joint or a "lubricated" surface between the inner and outer coats of asphalt or coal tar is effected. In other words, the steel pipe, the priming material, the first two layers of asphalt or coal tar, and the first layer of Cellophane or Kodapak, constitute one unit which will move freely within the second unit, consisting of a second layer of Cellophane or Kodapak, asphalt coating, and Kraft paper. This outer casing or wrapper, due to the stresses caused by expansion and contraction in the heavier types of soils, will be gripped as in a vise. The slip joint created by the two layers of Cellophane or Kodapak allows the pipe to



BEHIND THE TOOLS OF INDUSTRY

WITH EVERY TURN of the lathe, this cylinder increases in value. As metal, it is worth only a few cents a pound. But shaped, finished, as part of an automobile, a refrigerator, or a plumbing fixture, it becomes useful and valuable.

All over the world, G-E motors drive intricate machines. G-E apparatus controls their operation. The machines are shaping necessities for industry and for the home.

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Such advances, made possible, in part, by G-E research, come home to you in better quality and lower cost in the machine-made products that are part of your daily life. Every field of endeavor benefits by G-E research, that has saved the public from ten to one hundred dollars for every dollar it has earned for General Electric.

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contract and expand without breaking the bond between the coating and pipe. From recent examinations of pipe protected as above outlined and laid in heavy adobe soils where soil stresses are very severe, it appears that this reasoning is logical.—*A. E. B.*

Aeronautics in Naval Architecture

PROBABLY no two branches of engineering are so closely connected as naval architecture and aeronautical engineering. Ideas and progress in one field very soon make themselves felt in the other. That is why a paper, under the above title, by C. P. Burgess, the well-known airship authority, recently read before the Society of Automotive Engineers, has a decided appeal for anyone interested in either water or aircraft.

We are apt to be very proud of the various *Miss Americas* and their constructor, Gar Wood. But Mr. Burgess gives us some comparative figures which may make Mr. Wood less satisfied with his speedy hydroplanes. A modern flying boat such as the *China Clipper* will transport a ton of gross weight 16 miles at 125 miles per hour, with energy derived from one gallon of gasoline. In *Miss America X*, a gallon of gasoline will be responsible for less than two ton miles at 110 miles per hour. The flying boat has by far the best of it!

The difference lies in the ratio of lift to drag in the two types of craft. The *China Clipper* has a lift-drag ratio of 13 or thereabouts, whereas in the most efficient hydroplanes this ratio is only 5.

This difference is not due to the fact that the *Clipper* operates in air, and *Miss America* in water: the laws of flow and resistance are almost the same in both media. The explanation is that the *Clipper* derives its lift by "circulation" flow around the wing which is wholly immersed in the air. The hydroplane derives its support solely by the impact of the water on its under side, a far less efficient method of securing lift.

If the hydroplane is ever to have an efficiency comparable to that of the airplane, it may have to be carried at high speed by hydrovanes, metal wings totally immersed in the water and lifting the actual hull of the boat far out of the water.

The suggestion that hydrovanes be used for very fast water craft is not new. Graham Bell, in experiments in Nova Scotia in 1919, attained a speed of 60 miles per hour with moderate power and in spite of a choppy sea. More recently Dr. Tietjens of the Westinghouse Electric and Manufacturing Company has made interesting experiments along the same lines. Why is it that this idea is not more generally adopted, particularly if it is acknowledged that hydrovanes would give much smoother operation (being completely immersed) than the hydroplanes of to-day which undergo such terrific pounding?

The answer is that a number of practical difficulties are involved. The hydrovanes, to be efficient, should be long and thin and hence fragile. Also they are likely to catch up seaweed or floating objects. The hydrovane acts as a wing and derives the major part of its support from the suction on its upper surface. But when this suction reaches the atmospheric pressure of 14.7 pounds per square inch (or 2100 pounds per square foot) then the water leaves the upper surface of the vane and air takes its place. This phenomenon, termed "cavitation," not only means rapid erosion of the hydrovane surface but also complete loss of lift. And the critical speed at which cavitation occurs is only 27 knots.

Mr. Burgess also gives a few hints to those intrepid though somewhat archaic souls who cherish the arts of sailing and yacht building. He suggests that while the air resistance of a yacht is not as large as a streamline-conscious public might suppose, it is important nevertheless. Particularly in racing yachts it might be advantageous to round the edges of deck erections, make the decks flush, make the masts streamline, and provide devices for revolving the mast. These devices have been considered by others from time to time, but yachtsmen are people of tradition and do not like to depart from accepted forms. In fact, racing rules prohibit such devices. It would be interesting to see a sailing race in which all such rules were held in abeyance and in which aerodynamic ideas for hull and sails were given free play. Some wonderful new records might be made by our yachtsmen!—*A. K.*

Bright Finished Aluminum

WITHIN the last few years research and invention have solved the problem of the aluminum reflector for lighting purposes, and the solution may be aptly designated as "brilliant" in both senses of the word, says *Chemical and Metallurgical Engineering*. An anodic electrolytic brightening treatment which raises the reflectivity of a buffed aluminum reflector from about 70 percent to approximately 85 percent, while fully retaining the specular quality of the original surface, and which then can be protected with an oxide coating that causes substantially no reduction in reflecting efficiency and is resistant to weather, would have seemed a fantastic dream to the industry five years ago. The Alzak process is now doing this commercially to the satisfaction of the world's foremost lighting engineers. This, of course, opens up a new market for aluminum in a field where silvered glass or silvered brass formerly held almost undisputed sway.—*A. E. B.*

Rotary Duplicator

FROM England comes a new and simple spirit duplicating machine which operates in a fashion similar to the hectograph and mimeograph processes but is superior in that it will reproduce in colors. This machine, called the Fordigraph, is now being distributed in the United States.

In operation, a piece of hectograph carbon is placed with its ink side on the back of a sheet of master paper. Typing, sketching, or writing is then done in one, two, three, or four colors, as desired, by the application of different colored carbon papers. The master sheet is then ready to be placed on the large roller of the Fordigraph, from which copies may be made at the rate of 40 per minute or more.

The machine does not use stencils, gelatin or ink; instead it is necessary only to use the hectograph carbon and to moisten the reverse side of the master sheet by a liquid which is carried in the tank of the machine.

The moistening is, of course, automatic.

It is claimed by the distributors that tissue paper may be run on this machine without wrinkling and that regular letter paper, postcard stock, cardboard, or blotters may follow the tissue without any adjustment of the machine. It is further claimed that 500 or more copies can be obtained from a single master sheet.

Eradication of Syphilis Possible

A BATTLE cry against one of man's most dangerous disease enemies was sounded by Dr. Thomas Parran, Jr., New York State Health Commissioner, at a recent meeting of the American College of Physicians. It was a stirring "fight talk" from a leader to his captains in the war on disease.

This disease ranks with tuberculosis and cancer as a major cause of death. It causes untold misery; denies many married couples the privilege of parent-hood; causes helpless, innocent children to be born blind or deaf; cripples, and finally drives insane, many of its luckless victims.

The name of this dastardly disease is syphilis, a word that many persons do not like to speak or print or read. Not so long ago there was the same feeling about cancer, tuberculosis, even appendixes and gall bladders. Yet these have become part of every-day speech. Syphilis must also be read about and heard about so that this deadly foe can be vanquished. Refusing to name the enemy ends in defeat, not conquest.

This disease enemy of the unmentionable name, syphilis, can be conquered, Dr. Parran told the physicians. The outlook for the control of syphilis is far more hopeful than for the control of cancer. It is far more hopeful than was the outlook for the control of tuberculosis 30 years ago.

"The practical control and even eradication of tuberculosis in this country is a goal clearly in sight," said Dr. Parran.

By comparison, the job of controlling syphilis should be far quicker, for medical scientists know the "germ" that causes the disease. They can diagnose the disease as soon as the patient becomes infectious and dangerous to others. They have remedies which will quickly make the infectious patient non-infectious and prevent his giving the disease to others.

The big thing is to think of syphilis as a disease, to think of the person who has it as a sick person whose ailment is catching, but who can be treated so that in a short time he will not be in danger of giving the disease to anyone else. Another hopeful thing about this disease is that, if discovered and treated thoroughly at the start, the damage it may do to body and brain and to future generations can be prevented.—*Science Service.*

Makes Heat Transfer Visible

CALCULATION of the rate of heat flow is a common but often very complicated problem for the chemical engineer. While others have been working out complicated mathematical formulas for the solution of this problem, Prof. A. D. Moore, of the University of Michigan, has been devising a clever apparatus in which he can actually watch the flow of heat and measure it with a ruler. The Moore device, demonstrated at a recent symposium on heat transmission at Yale, is known as the Hydrocal. It operates on the principle of causing water to flow in a manner exactly analogous to heat, by forcing it through capillary tubes of calibrated resistance. The flow is streamline and, as in heat flow, the rates are directly proportional to driving force. The height of the liquid column is exactly analogous to temperature. Solving a problem consists of connecting the correct resistance tubes in the apparatus, opening some valves, and reading water heights on a series of manometer tubes at the end of specified times. The device is particularly useful for problems of the unsteady state and for some cases, such as an irregularly varying heat source, makes solutions possible which are impossible with formal mathematics.—*A. E. B.*

Babylon's "Solid Beer"

"SOLID beer" was a standby of the Babylonians and ancient Arabs when they went on a long journey. Just what this stuff was, and how it was made, has been traced by Prof. Paul Lindner, veteran Berlin bacteriologist, with the assistance of Dr. Engelbert Huber, student of the history of brewing.

The early Arabs, according to ancient texts, knew the "solid beer" under the name of "saviq"; their predecessors, the Babylonians, gave it the more bubbly title of "hubur bulug gar." It was not sold by liquid measure, but in lumps by weight, and was carried wrapped up in packages on camel-back. When the caravan made camp, some of the lumps were soaked in water, and the mixture quickly fermented into a refreshing drink of low alcoholic content.

The lumps of "solid beer" appear to have been made of a special kind of bread, in which barley malt was a prominent ingredient, and frequently containing also a considerable proportion of sweet date pulp. This bread was baked at a moderate temperature on hot stones, and then packed up.

The quick fermentation, Prof. Lindner is convinced, was due to the action not of yeasts but of a species of bacterium which he himself discovered and identified some years ago, known as *Termobacterium mobile*. It is found in warm regions throughout the world, and plays a leading part in the quick fermentation of the milder beers made of palm sap and other ingredients by primitive peoples. Prof. Lindner believes that this bacterium would be left unkilled by the mild baking of the "saviq," and that it would readily find its way into the mash by soaking it in water.

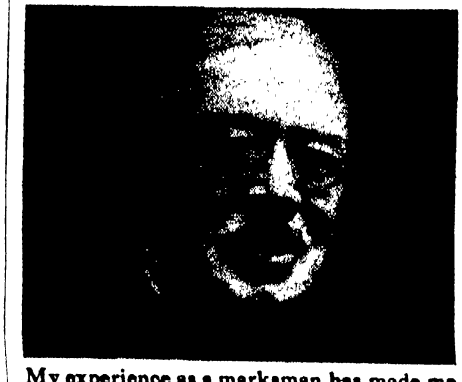
The art of making "saviq" has apparently been lost by the town-dwelling Arabs of the Near East, but it may possibly survive among the nomadic tribes of the desert.—*Science Service.*

Insanity Increase

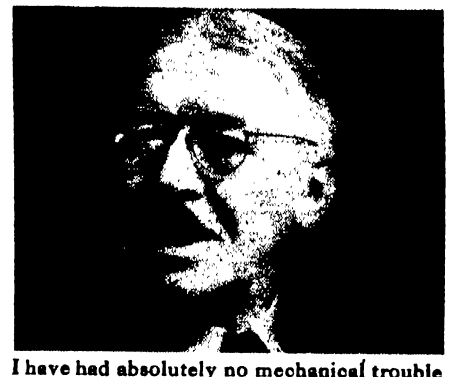
TIME and time again the question has been asked: "Is not the stress and strain of the depression responsible for the great increase in mental disease in this country?" Time and time again that question has been answered in the negative, and the correct explanation given. Yet the explana-

"Dodge Scores a Bull's-Eye With Me"

Says MAJOR M. E. TRULL, Noted Marksman



My experience as a marksman has made me intolerant of anything mechanical that is not efficient . . . the new Dodge scores a bull's-eye with me.



I have had absolutely no mechanical trouble with it . . . it rides and drives like a dream.

I haven't found another car that has all the safety features combined in one car that my Dodge has . . . and here's the "clincher" . . . I'm getting many more miles to the gallon of gas than I ever got before!

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tion seems not to have reached many people, for the question reaches us over and over from different quarters.

Dr. Carney Landis, of the New York Psychiatric Institute and Hospital, recently stated the case plainly. In 22 years, he said, one type of mental disease has increased from 2 per 100,000 to 14 per 100,000—a rise of almost 700 percent. But this is the *only* type that has increased during those years, and it affects *only* persons beyond middle age. This particular type of mental disease is due to a hardening of the arteries of the brain.

The reason for the increase is, therefore, obvious. Due to the great advance in public health work and preventive medicine, we have more old people than formerly. Twenty-two years ago, about one fifth the population was 45 years old or older; but this group had increased almost to one fourth in 1934.

"After all," said Dr. Landis, "a man must die of something, and if typhoid does not take him at 30, hardening of the arteries in the brain may at 60."

SIX NEW AIR RECORDS

THREE American aviators brought three international air records to the United States during February, besides setting a like number of national records.

Miss Helen Richey of Pittsburgh, Pennsylvania, flying an Aeronca C-2 Scout established a national and international speed record for 100 kilometers for Class C, light airplanes at a speed of 72.224 miles per hour.

Terris Moore of Cambridge, Massachusetts, captured an altitude record for light seaplanes, third category, Class C, in an Aeronca C-3, reaching an altitude of 11,558 feet, establishing both a national and international record.

Miss Iona Coppedge of Dayton, Ohio, in an Aeronca C-3, set a feminine altitude record for light airplanes for the third category, Class C, by reaching an altitude of 15,253 feet. No record had previously been established in this category and accordingly the present one stands as both a national and international record.

The standing of nations with regard to international aviation records at the time of writing is: United States 42, France 37, Italy 28, Germany 8, Poland 8, and England 1.

A BANNER YEAR FOR AVIATION

THE year 1936 has opened up for American aviation in the most auspicious manner. Large Army and Navy contracts; a war scare in Europe; higher airmail rates; ever growing volume of passengers, mail and express; and a promising private plane market, all combine to make the industry extremely cheerful.

Technical progress is certain to keep pace with growing prosperity. Even in the leanest of the depression years, American aviation progressed steadily. Profitable operations will induce even greater advances in construction and operation of aircraft. It is not out of place, therefore, to expand a little on the predictions of immediate developments which are made by Jerome Lederer of Aero Insurance Underwriters:

1. *The adoption of the nose-wheel undercarriage for small airplanes.* The Department of Commerce development program of

a light plane for private flying has not been revolutionary to date, but it certainly has shown the value of the front wheel in preventing nosing-over and in decreasing the hazards of cross-wind landings.

2. *The installation of independent auxiliary power plants in large transports to supply energy.* Power is now needed in the transport airplane for radio, lighting, starting, and operation of the retractable landing gear and flaps. Sooner or later the controls themselves will be power operated. Instead of batteries, wind driven generators, or geared connections to the engine, it would indeed seem logical to install an additional unit to take care of all these miscellaneous power requirements.

3. *Higher payloads through greater fuel economy and higher octane fuel.* With more power it is possible to secure greater speed, which really means lower costs in operation.

4. *Counter-propellers to absorb the torque of high powered engines on single-engined airplanes.* When the power of a single-seater fighter approaches 1000 horsepower, the torque generated by the engine and propeller becomes relatively so high that lateral control is difficult. We understand that the Army Air Corps is even now considering proposals for the design of tandem propellers driven by the same engine, but rotating in opposite directions so that the torque effects are eliminated.

5. *The use of the catapult for starting heavily-loaded ships.* While Mr. Lederer is predicting the catapult, the Mayo-Short composite aircraft is nearing completion in England. As our readers will remember, a small heavily loaded flying boat is to be carried above the wing of a very large flying boat, and is to be released when sufficient altitude has been reached.

Mr. Lederer's predictions are both timely and logical.—*A. K.*

"Radio" Alarm Foils All Intruders

THE kidnapper and the thief, the two oldest human parasites, today menace the property owner of position more than ever before. All people of prominence and means are potential victims of these desperate enemies of society. Daily we read of invaded homes, of children, adults, and elderly persons attacked and injured by intruders. People are kidnapped from their own residences at the point of guns. Treasured possessions are stolen or wantonly destroyed by vandals. While such conditions persist, people of position cannot afford to be without protection against the marauder.

About two years ago, an organization of expert electrical engineers foresaw the wave of kidnapping and violence now sweeping our country. These men turned their energies towards devising an adequate and foolproof protective system for the fine home. The Teletector Property Protection System was the result. Today this scientific development is installed and operating in many fine homes, guarding against trespass.

The Teletector is a sensitive electrical apparatus operating on advanced radio principles, the function of which is to encircle all doors, windows, or openings in a home or nursery with an invisible "radio"

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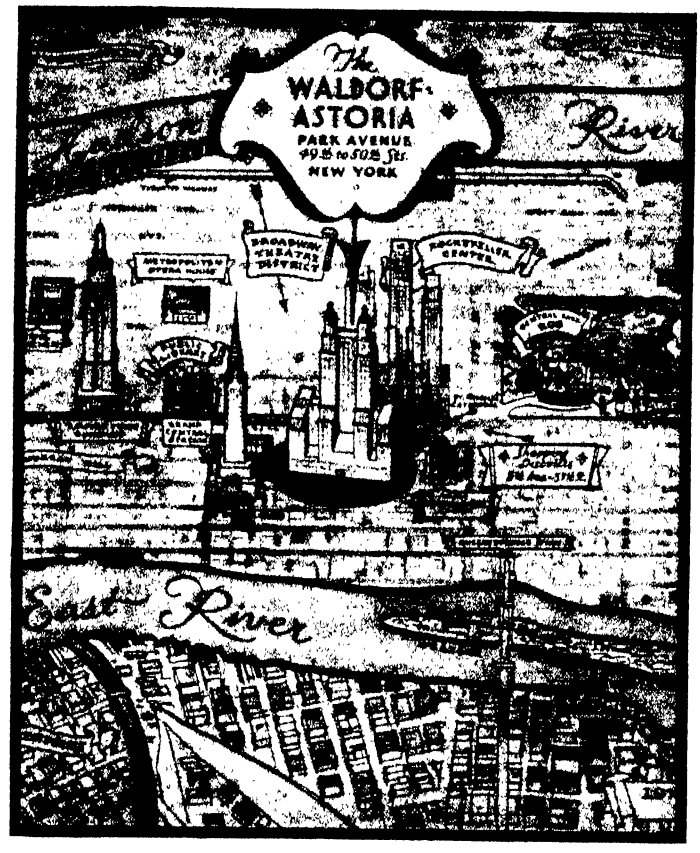

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THE AMATEUR TELESCOPE MAKER

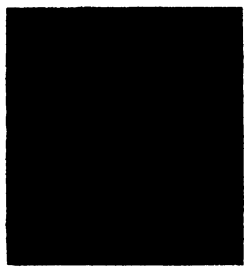
Conducted by ALBERT G. INGALLS

IN this magazine last June Professor Russell described the Schmidt telescope—or camera, to speak more exactly, since it cannot be used to advantage as a visual instrument—and this present month with his article (pages 248-249) we have reproduced photographs, one celestial, the other terrestrial, taken with a Schmidt made by the Lowers of San Diego. The little picture on the present page is another, and the camera itself, its box uncovered, is shown at the bottom.

For photographic work the Schmidt telescopic camera, with its oddly curved correcting lens in front, is as far ahead of a telescope camera having an ordinary paraboloidal mirror without a correcting lens, as a paraboloidal mirror is ahead of a spherical mirror for usual work—farther, in fact. Oddly enough, the Schmidt reverts to a spherical primary but it is its correcting lens that does all the business of knocking out the coma that otherwise puts tails on star images at the edge of the plate and, in fact, on all except the central eighth of a degree or so of plates taken with paraboloidal mirrors such as the 100-inch. But a Schmidt gives a good field 12° or more diameter—no tails. The spherical primary is said by some writers who have never tried to make a real sphere to be easier than a paraboloid but, be that as it may, the real grief or "piece of resistence" in the Schmidt job is in the correcting plate. This is a thin piece of glass at the outer end of the tube, its curve so inconspicuous that the plate resembles an ordinary piece of thin, unaltered glass. But the extremely shallow curve is neither spherical nor paraboloidal but decreases in radius as the edge is approached, and it must be made by means of a flexible lap and a combination of patience, intuition, experience, bad language, cut and try, and occasional sheer good luck. It is not beginner's work and perhaps it is not merely fairly experienced work, but definitely is advanced work. The whole business—theory and practice—will be covered in the "A.T.M. Supplement," due in a few months—please don't ask when, for this depends on when the last cunctative contributor sends in his material. The last contributor whose long-promised "copy" comes in is to receive a prize of an invisible telescope in an intangible, imponderable carrying case.

In the meantime, here are Harold Lower's comments on some of the first photographs he and his father, Charles Lower, took with the Lower Schmidt, which embodies the famous "Soup Bowl" mirror. "The 'candid camera' shot of Dad lighting a cigaret shows what one second exposure does, by the light of a match," he writes. "This is made at a distance of 12 feet. Lens wide open. The night picture of San Diego (page 249. —*Ed.*) was made from Point Loma, across the Bay. Exposure 10 seconds, and over-exposed. By examining the negative with a glass one can count the windows in buildings which are more than four miles away, but it is so badly over-exposed that they don't show in the print. The two pictures of the camera with one side removed were made before the interior was blackened, so as to show the parts in position."

The crossed strings in the left hand (lower) picture were placed there for help



Lower Sr. caught smoking cigaret

in the very delicate, critical collimation, and are not a permanent feature.

ON the opposite page are drawings of two items from Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada. The first is a gadget to permit easy reading of setting circles in the dark. "The scale proper," Wates writes, "is a disk of 1/16" Celluloid, one side of which is sprayed with black Duco. The scale divisions are cut through the Duco with a sharp knife, and the numerals scratched with a scriber. Work with a light under the Celluloid. This method gives very fine markings.

"The scale is attached to a collar which clamps to the declination axis by a set-screw. The drawing shows the common German type of mounting, but the same principle could be adapted to any mounting. The lens is a ten-cent magnifier. The mirror may be thin glass, silvered on the front and lacquered. I used a bit of chromium plated metal. The 'index' is a piece of Celluloid with a vertical line scribed and blackened. It should be as close to the scale as possible, in order to avoid parallax. Note that the Duco side of the scale must be next to the lamp, and that the base of the numerals must be toward the edge, as the mirror inverts.

"The lamp is a 3-volt flashlight globe working on one cell, to give a faint light. The socket and one side of the switch are 'grounded' on the mounting. This scale is delightful to use. The divisions are seen very clearly, yet the eye is not dazzled as when using a flashlight."

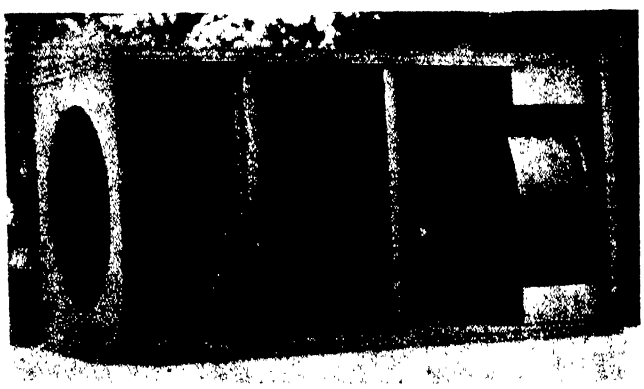
It is suggested that the light be of as low candlepower as will clearly reveal the markings, thus not unduly causing the pupil of the observer's eye to close. Mr. Wates' next item is a suggestion for a drive for an equatorial mounting. The drawing is his.

"This drive is planned for a very heavy, double yoke mounting for a 12" telescope, but could easily be adapted for other mountings, such as the common German type, by means of an extension on the polar axis.

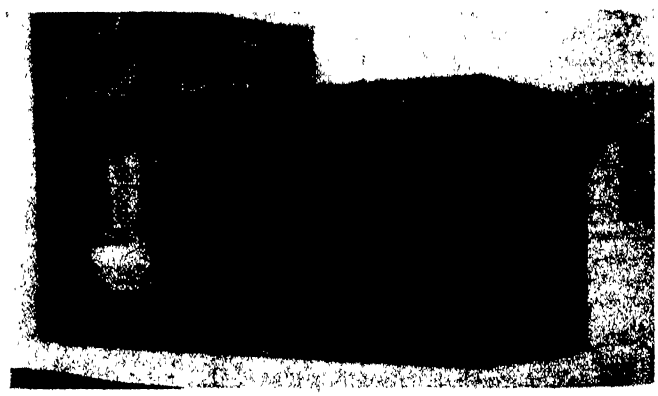
"The actual drive consists of a screw such as is used in screw-cutting lathes, with a split nut. These screws are accurate within .0003" per inch length. The nut runs in guides (not shown), and has a thrust ball bearing at the top. The screw turns (by means of suitable gearing) at a speed slightly in excess of 30 rev. per hour. The motor should be variable speed if possible.

"Mounted on the polar axis is a pulley, 72" in circumference. A suitable pulley could be picked up at any junk shop, although possibly not of the exact diameter. It would be a simple matter to alter the design and gear ratio to accommodate any pulley or screw that happened to be available.

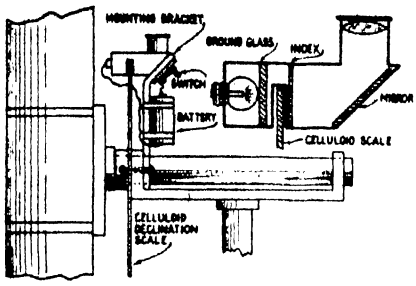
"On the left is a heavy drive weight suspended on a suitable steel wire passing around the pulley. On the right is a steel tape attached to a yoke, which in turn is fastened to the nut. The wire and tape lie



The interior of the Lower Schmidt camera. Note stops



Same interior, showing thin, clear correcting plate



Wates' circle reading gadget

on the pulley side by side—they are not joined. Each is fastened to a stud on the face of the pulley. The pulley is a loose fit on the polar axis and can be clamped thereto by a clutch, not shown. The fine adjustment is obvious from the drawing.

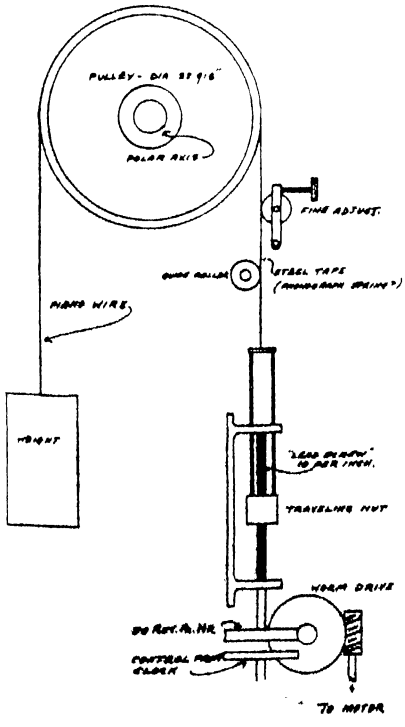
"Exact speed control will be by the so-called 'Chaser' system. The wheel marked 'control from clock' is not attached to the screw drive in any way, but is an entirely separate wheel driven by a pendulum clock at 30 rev. per hour sidereal time. A contact on this wheel plays between two contacts on the screw drive wheel. If the latter gains, the motor is slowed down, and vice versa.

"No means of restoring the nut to the bottom of the screw is shown, but it is planned to have the motor and gears slide to the right, disengaging the worm and engaging a suitable gear direct from the motor shaft to restore the nut and weight. Contacts will of course be provided so that the motor will be shut down when the nut reaches the bottom.

"Except at the equator, the piano wire will run over a pulley to the weight."

"IN all fairness to others and to the best of my belief I feel I can safely lay claim to the distinction (if any) of having the smallest observatory of any practical use. It measures exactly 60" x 17" x 25". To be precise, it is the scuttle hole to the roof of the house."

This is our old friend Bill von Arx, broadcasting a fighting challenge to the world



Proposed telescope drive—Wates

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von Arx's petite observatory

from his sky hole observatory at 573 Monroe St., Brooklyn, N. Y. What he writes shows the sad circumstances under which we poor metropolitan observers work (kindly start weeping here); in fact, your scribe's telescope is now in moth balls in the attic, because a gas station 200′ distant has converted his yard into near daylight with three big flood lights. For two cents the company's name would be revealed: a famous ocean was named for it. In revenge, no gas is being bought there—will the company fail? But to return to Bill von Arx with his head sticking out of the sky hole.

"Being one of the many sufferers from city lights and cold wintry breezes," he says, "I mounted a small equatorial camera on the southern edge of the scuttle, as shown in the photograph. Standing on a substantial shelf 60″ below the level of the roof it is quite comfortable to do all the observing and photographing any avid amateur might want to do. Of course, several regions of the sky are obscured by neighboring chimneys, ventilators and vent pipes, but in the main these are not disadvantageous because the sky light in the lower altitudes is so bright that most of the stars are lost.

"Besides the equatorial camera I have a little 80-mm. triplet telescope of 22″ focus and doubtful pedigree, on a mobile alt-azimuth mount which can be trundled to the roof level with little difficulty. It is mounted on a pair of two by fours about 2′ long, joined at right angles at their ends. Resting the legs of the mount on the combing of the scuttle—the mounting being fastened at the union of the two—it is quite easy to move this little glass in any position favorable for the observation being made. This manner of mounting has proved more than satisfactory in that it is light, easy to handle, and quite rigid even in strong winds.

"Between the roof and the ceiling below there is a space a little over a foot high which makes a very convenient place to keep odd maps, books, binoculars, eyepieces, as well as the two instruments mentioned above. A board laid across the ceiling makes a convenient desk for jotting notes. This is even more comfortable when a stool of small dimensions is squeezed up on the shelf with the observer. An extension cord from the outlet in the room below gives current for the drive clock on the equatorial, as well as for a small ruby light for reading charts, etc."

We asked Bill what his family does for heat while the sky hole is open and he tells us the family heat simply passes out, after which the seeing is better. Whether the family does the same seems uncertain, but it was a cold winter.

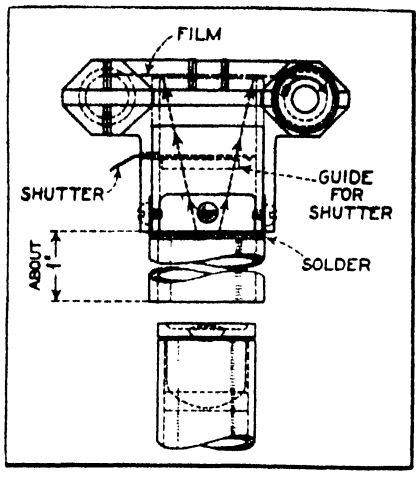
R. E. CLARK, Box 112, Langeloth, Pa., writes: "I have been experimenting with the following wrinkle, which I think is new, and thought you would care to pass it along to some of the fraternity who make a specialty of spoiling good glass. Instead of using glass for a tool, try the following: 4 parts clean, 60-mesh silica sand, 2 parts clean, 200-mesh silica flour, 3 parts Portland cement. Add lots of water and mix again very thoroughly. Pour into a mold the size you want your tool. Eliminate all air bubbles by stirring with the finger, smooth off the top, which will be the back of the tool, and allow to cure for 72 hours. If properly made there is little danger of scratches from detached grains of sand. Use plenty of water in mixing, so that the sand grains will segregate and form the working face."

GEORGE MEIGHAN, 774 34 St., North Bergen, N. J., suggests this dodge: "Instead of using the glass tool I use a round metal plate—stove lid or other. If the pitch hardens before I can get the grooves properly made, I hold the plate over the gas burner and soften it up again."

NOW and then someone sends in a blueprint of a telescope, made at some cost of labor, and wishes it reproduced. A blueprint cannot be reproduced at all. The tracing is reproducable but generally the draftsman forgets that when the drawing is reduced the lettering will be reduced in proportion. In general, we dislike blueprints, which smack of the standardization idea. Drawings of individual features of telescopes are of interest, but few wish to "copy" a whole 'scope.

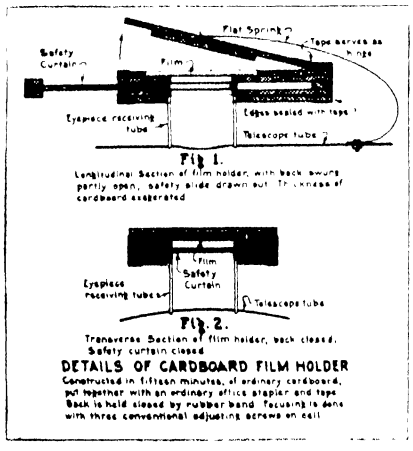
AND now a club of telescope enthusiasts has been organized in St. Louis, the "St. Louis Amateur Astronomical Society," which is the astronomical section of the St. Louis Museum of Science and Industry. C. F. Hellweg, 5246 Cote Brilliante, is the secretary-treasurer.

Orion as photographed by von Arx with camera shown above. Exp. 60 m. f/4.5, Schneider Xenar 10.5 cm. focus. Gaevert Super Chromoss plate



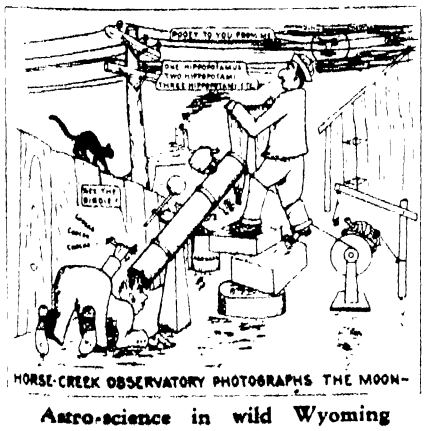
Mowry's photographic adaptation

THE top drawing, after a little study, shows how Nelson A. Mowry, 302 Garland St., Edgewood, Pittsburgh, Pa., converted a 39-cent Model A Univex camera into a celestial camera for attachment to a telescope. The lens and shutter were removed and a brass shutter inserted into a jig-sawed slot. Good pictures an inch in diameter were taken.



Johnson's simple film holder

In the second drawing, made by Vance Johnson, 821 West 27th St., Cheyenne, Wyoming, this draftsman-artist-telescope-maker shows how he and "Bertha" (that is his telescope—Bertha Johnson), and the other cow hand photographed the moon, using Pan film and a dingbat of their own invention. The lower objet d'art, also drawn by Johnson, reveals details of the new Cheyenne Mounting, with its slow motion drive.



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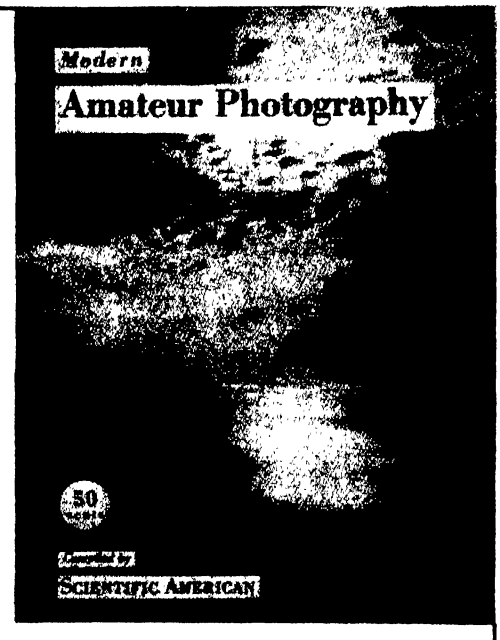

IN this comprehensive and attractive collection you will find a well-rounded discussion of the miniature camera, together with a list of those available in this country; an article on candid photography; others on the use of exposure meters, telephoto lenses, creative enlargement, infra-red and ultra-violet ray photography, color filters, picture composition, indoor photography, pinhole photography, astronomical photography, and many other subjects. In addition there is a carefully chosen list of the most helpful books published for amateur photographers.

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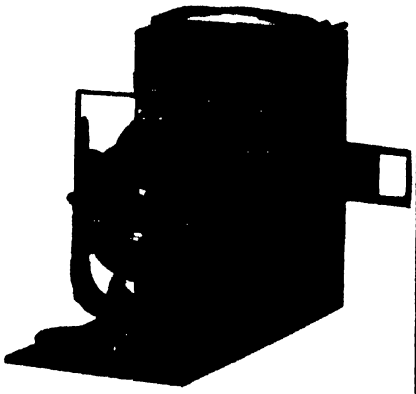

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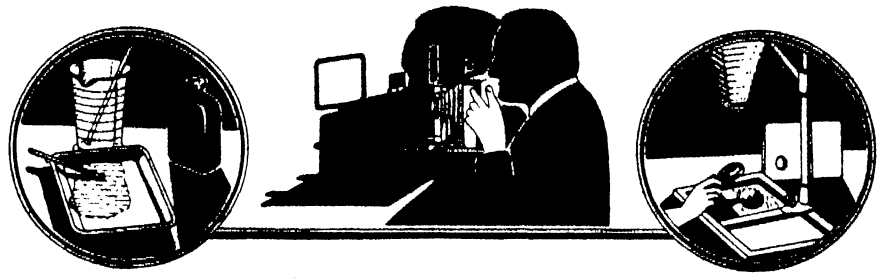

CAMERA ANGLES

Conducted by JACOB DESCHIN

Travel Photography

To travel without a camera is to forfeit half the value of a trip—the aftermath of pictured memory. Everyone realizes this, so practically everyone who goes a-journeying, however little he or she may know about photography and even if the outfit is the most modest, packs a camera and films as one of the necessities to be included even at the cost of leaving something else behind. The more zealous the photographer, the more sacrifices he will be willing to make in this regard.

Don't neglect buildings

Whether it is mountain, land or sea, subject-matter will be found everywhere. We have but to look for it. A little reading of photographic literature dealing with the type of atmosphere—sea or high altitudes or land and sky or whatnot—into which you are traveling will help to jog memory on some points you may have forgotten and in addition give some valuable hints you had not thought of, as well as project you into thinking along the photographic lines which cover the type of pictures you will most likely be making.

In general, it is advisable to take one of the relatively smaller cameras, not necessarily the miniature type, although the latter can be very useful for the reason that they are so convenient and easily accessible, and because they carry a large loading of film at one time, thus obviating changing film rolls too often. A camera equipped with a range finder or one of the small reflex cameras would seem most suited for travel purposes, although other types of cameras up to 3¼ by 4¼ and 4 by 5 inches will be found easier to work with if landscapes and similar subjects are what you seek most to get. Range finders for cameras not so equipped may be had today at a low cost. In the case of the larger cameras you will now and then wish to use a tripod and focus on a ground glass. Ground glasses have been known to drop and break, leaving the worker helpless and the camera well-nigh useless, so be on the safe side and take along an extra one.

Be generous with your film supply. It is hard to estimate how many pictures you will be likely to take. The number will depend on the type of pictures to be made, the picture-taking opportunities offered by the locality, the length of time you plan to be away and on a number of other considerations which will come up in individual cases. Take as much film as you can accommodate; film you do not use on the trip can always be used up on returning home. Include in your equipment a light tripod, a lens sunshade, a filter or two (an ultra-violet one if you plan to take pictures from mountain peaks), a good exposure meter—a photographic "diary" in which to record exposure data and one or two other small items that may seem to you important. By no means, however, need you take along equipment for processing negatives en route. You are not trying to make a deadline—you go on a vacation trip to get away from deadlines—so you can take your time about seeing the results of your handiwork. Besides, processing negatives en route would take time and trouble which should be de-

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Read the rules carefully and then go to work. But please be sure that your entries comply with all the rules as the Judges cannot be held responsible for entries which do not.

RULES OF THE CONTEST:

1. Photographs entered in this contest must depict some phase of science, industry, engineering, aviation, or kindred subject.
2. Entries will be judged on the basis of pictorial value and photographic technique. The decision of the Judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.
3. All of the photographic work involved in producing prints for this contest must be done by the contestant.
4. Photographs submitted must be printed in black and white on glossy paper and must be mounted.
5. Prints must not be under 7 inches or over 14 inches in their longest dimension. Mounts must not be larger than 14 by 17 inches.
6. Photographs must be submitted by first class mail, with sufficient cardboard included in the package to protect the print.
7. Each entry must have the following information written on the back of the mount:

   Name and address of contestant;
   Camera and lens equipment used;
   Size and emulsion of negative;
   Filter used, if any;
   Diaphragm opening and time of exposure;
   Month, time of day, and quality of light;
   If indoor, contrast of paper used;
   Developers used for negative and paper;
   Additional aids employed.
8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.
9. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.
10. Non-winning entries will be returned only if postage is included when the prints are submitted.
11. No entries will be considered from professional or commercial photographers.
12. All entries in this contest must be in the hands of the Judges by June 20, 1936. The results will be announced in our issue dated September, 1936.
13. This contest is open to all amateur photographers who are not in the employ of Scientific American.

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voted to the purposes for which you took the trip—rest and picture-taking. Take care, however, that you mark the exposed film rolls or packs in some way to identify them and take the additional precaution to segregate them in some definite place in your grip away from the unused material.

Nor ought you to yield to the temptation, however strong, to see "how they came out" and rush to the nearest local photo finisher. He may do a good job, but on the other hand, he may do an awfully bad one. At any rate, why take the chance?

Vacation trips imply a period of two or three weeks for most of us. For this reason we should take pictures as we meet them and not put off until the next moment what can be done right away. The first impression is the freshest and most vivid. If a subject strikes you "right between the eyes" —or in the heart—lose no time to record it in the best way you know. You may never feel exactly that way about it again.

On the return home, survey your developed negatives with a critical eye. The enthusiasm and excitement of the moments when the pictures were made are gone, so you can look upon the results in a relatively objective way. Do not hesitate to throw away what seem, on afterthought, to be

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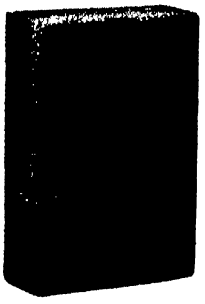

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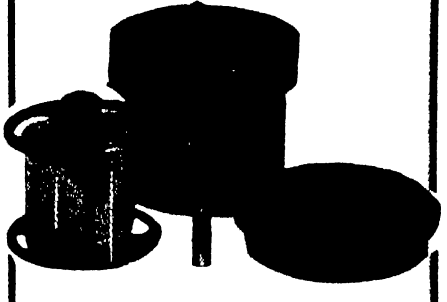

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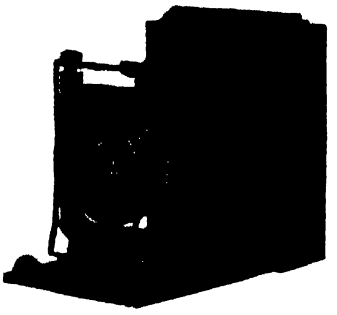

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worthless things, but watch for the "worthless" negative in which some detail may be salvaged by the enlarging camera and turned into something quite presentable. The resultant batch may be printed up for arrangement in a book which will ever after call up the memory of the trip as no mental recollections of it can ever do.

Daylight Silhouettes

SILHOUETTES of persons or objects taken indoors by having the light behind the person or object and the shadow projected on a white sheet may be duplicated with outdoor lighting and without the use of the sheet. The accompanying illustration shows how this is done. The exposure, of

". . . against the outside brightness"

course, is based on the outside light. The interior in which the subject is placed being relatively dark, even with normal lighting in the room or other enclosure, the subject is silhouetted sharply against the outside brightness. A profile, of course, is essential, and the "true" silhouette, the one in which no detail whatever appears, is the most striking. However, a "semi-silhouette," where the front part of the face has some light on it, is sometimes effective too. The "semi-silhouette" is made by having a person close to a window or door. To insure a "true" silhouette, on the other hand, the person must be placed a bit away from the window or other aperture so that the daylight does not strike his or her face directly.

Glycin Paper Developer

USUALLY associated with fine-grain film developing, glycin has now been adapted by the Edwal Laboratories for use as a paper developer. In perfecting the developer, trisodium phosphate was substituted for potassium carbonate and three formulas evolved; the Edwal 102 for deep black tones, the Edwal 106 for brown tones on chloride and chlorobromide papers, and the Edwal 108 for greenish or olive tones. No. 106 is called a "stunt" developer by the manufacturers because different tones can be had by lengthening exposures, the longer the overexposure the browner the print, with chloride papers capable of being toned in this manner to reds, greens, and sepia tones. All these developers are obtainable

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Leica Manual, *by Willard D. Morgan and Henry M. Lester.* A beautiful book of over 500 pages dealing with all phases of miniature photography. It covers such subjects as panoramas, photomicrography, dental, stage, and aerial photography, photomurals, infra-red, and many others. $4.00.

Practical Amateur Photography, *by William S. Davis.* Deals with the whole subject from the origin and growth of photography to the latest types and uses of cameras. 264 pages, illustrated. $2.40.

Photographic Enlarging, *by Franklin I. Jordan.* A complete treatise on enlarging, discussing not only the necessary equipment but all of the darkroom processing, dodges which may be employed, combination printing, mounting, and lantern slides. It is written in a light yet thorough-going manner. $3.70.

Free-Lance Journalism With a Camera, *by Rufus H. Mallinson.* Many serious amateur photographers would like to know how to make money with their cameras, here is a complete guide to that work. It tells not only how to make salable pictures but also how to market them. $1.65.

The Fundamentals of Photography, *by C. E. K. Mees.* Not only tells how to take and finish pictures but gives a solid foundation of the principles of photography. $1.10.

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in made-up form, an arrangement becoming increasingly popular for many types of formulas because of the convenience of not having to weigh out the individual chemicals. It is much simpler just to add water and mix.

35-MM. IN BULK

FOR those who buy their miniature 35-mm. film in lengths of 25, 50, and 100 feet and later cut them to the little over five feet accommodated by the magazine, Agfa has devised a convenient form of bulk film which does away with the necessity of measuring the required lengths in the darkroom. Their Agfa Superpan now comes packed in rolls of 27½ feet and 55 feet, the first divided into five lengths by notches to indicate where to cut the film, and the larger film roll notched for ten lengths. This gives a length of 5½ feet for each loading, which will give the usual total of 36 pictures.

NEW FLOOD LAMPS

A SERIES of lamps for indoor camera workers is now on the market under descriptive names which indicate their span of life. They are offered as "Five Hour Picture Flood," "Five Hour Filter Flood," "Fifteen Hour Jumbo Picture Flood" and "Fifteen Hour Jumbo Filter Flood." The term "Jumbo" refers to greater size and lasting time, the term filter to the fact that these lamps are made of a special blue glass said to be ideal for Dufaycolor use indoors.

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SCOTCH opaque photographic tape can be used for so many things that it is easily the handiest thing about the darkroom and studio. It clings to the surface immediately, requiring no moistening. If you happen to have made a mistake it can as easily be removed without leaving a stain. Thus it can be used over and over again, which is perhaps the reason for its name. It is opaque, waterproof, soft and pliable, and will not crack. When applied to the edge of a negative for masking purposes it will neither wrinkle nor curl the negative but will lie perfectly flat. Its uses include the holding of negatives to the plate glass during printing and for blocking out desired borders, for making masks and for binding lantern slides, for repairing broken negatives, photographs, and camera bellows. It does a more efficient job than thumb tacks or wetted gummed paper and gives a neat appearance to the finished product.

LENS HOOD AND SKY FILTER

DESIGNED for the Rolleiflex and Rolleicord cameras, a new lens hood and graduated filter has just been introduced with the distinguishing feature that the filter goes over the front of the lens hood, sliding vertically in a holder. The filter is adjusted with the aid of the finder lens, then transferred to the taking lens for the exposure. As is usual with sky filters, no increase in exposure time is needed. The manufacturers designed the new sky filter arrangement on the theory that the usual sky filter has little, if any, effect when placed directly over the lens; the new method, they feel, keeps the filter at the correct distance from the lens.

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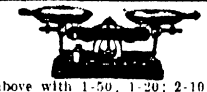

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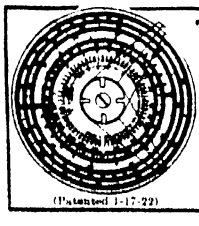

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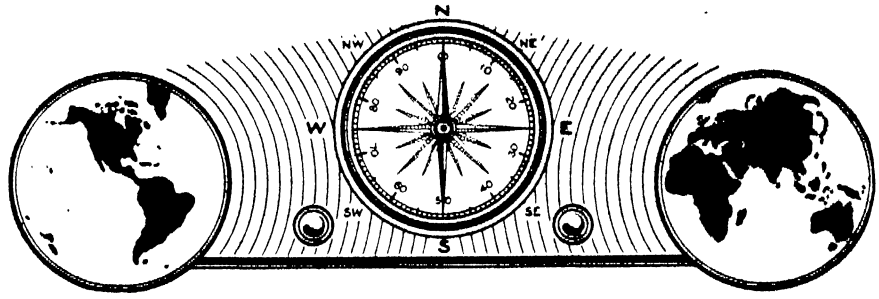

WORLD-WIDE RADIO

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"The Shadow" Discovered

No form of interference to radio reception has caused such intense interest, and speculation as to its nature, as has "the shadow." It has been attributed to the workings of a foreign government intent upon disrupting the communication channels of the world; it was thought by some to be the work of an intellectual crank; others have suggested that it might be some new and odd form of radiation from another planet.

It has fooled some of the best engineers in the field for the reason that its true location could not be determined. To make matters worse, it had been reported from England, from Africa, from Japan. It was heard on the high seas, and it was heard on practically every channel from 30 meters down. And it is still heard, but "the shadow" is no longer a mystery.

It has been definitely determined that this interference is the radiation, not from a single, but from a number of new type high-power diathermy machines used in hospitals and health institutions. The coils used for treatments, through which the high-frequency currents pass, act as excellent antennas; so excellent, in fact, that presumably a single machine in operation is capable of radiating a strong "sky wave" that can cover immense distances.

Steps are being taken to equip these machines with suitable devices to prevent radiation of the high-frequency power. Until this is accomplished, world-wide radio will have to get along as best as it can.

There are no limits to the repercussions of progress. Who would have believed that a listener in San Francisco could hear the electrical oscillations warming a man's leg in New York?

Smallest Micro-Wave Transmitter

The engineers of the National Broadcasting Company have designed an ultra short-wave transmitter so small that it just nicely fits the palm of one's hand. It looks like a toy but is far from being one: in exhaustive tests of the first working model completed, distances up to four miles were attained.

The midget transmitter is not intended for broadcasts direct to listeners' radio receivers, but for actual program service of the "Vox Pop" type, at any point of origin, to extend the scope of pick-up for present radio networks.

Announcement of the tiny transmitter marks the first NBC disclosure of results of more than two years' experiment in the micro-wave field, as part of the extended series of ultra-short-wave propagation tests conducted in the field and from the tops of skyscrapers in New York.

The new micro-wave unit, as explained

The smallest micro-wave transmitter, showing the two-rod antenna

by O. B. Hanson, chief engineer of NBC, is the culmination of attempts to develop a "coat-pocket" transmitter to enable footloose announcers to carry a microphone to any desired point, or circulate at will among large assemblages, for purposes of broadcasting or to feed a public-address system from the floor of a hall or auditorium. The transmitter is not available commercially.

Hanson explained that investigations in the micro-wave field suggested that work in the band of 300,000,000 cycles and more would permit the use of the midget antenna equipment necessary for the compactness sought. Micro-waves also offered a phenomenal degree of penetration through intervening structures, so the tiny waves were employed in developing the new portable transmitter.

Earlier units of portable type, more cumbersome in size and operating on longer wavelengths of the order of 7 to 10 meters, were tested by NBC during the Horse Show at Madison Square Garden last fall, where they worked with marked success in relaying instantaneously to the gallery the decisions of the judges on the floor.

In its present stage—as shown in the accompanying illustration—the micro-wave

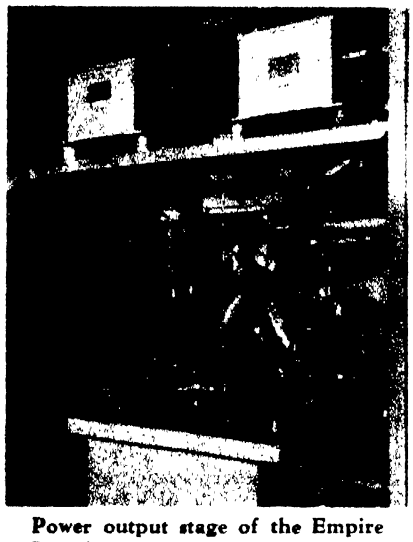
*Editor *All-Wave Radio*

set is a three-inch cube, with two ten-inch rods as the antenna system. It transmits on a wavelength of one meter or less at a power of two tenths of a watt. The latest type of RCA "acorn tube" is used. One of these small tubes is shown on the table in the illustration.

Current is fed to the midget set by a small battery unit of 90 volts. The complete battery unit weighs less than four pounds; the transmitter proper less than a pound.

British Broadcasting

THE Empire Broadcasting Service of the British Broadcasting Corporation recently completed its third year of operation. With the addition of a sixth transmission period added last year, designed



Power output stage of the Empire Broadcasting station at Daventry

primarily for listeners in Western Canada and audible in the United States, a daily program from Daventry became available for all parts of the British Empire at convenient local listening times.

The present wavelengths of the Empire Transmitters, and their call letters, are as follows:

Call	*Frequency* (Megacycles)	*Wavelength* (Meters)
GSA	6.05	49.59
GSB	9.51	31.55
GSC	9.58	31.32
GSD	11.75	25.53
GSE	11.86	25.29
GSF	15.14	19.82
GSG	17.79	16.86
GSH	21.47	13.97
GSI	15.26	19.66
GSJ	21.53	13.93
GSL	6.11	49.10
GSN	11.82	25.38
GSO	15.18	19.76
GSP	15.31	19.60

Correspondence received by the Corporation from overseas listeners exceeded 27,000 letters and other reports, approximately double the number received in 1934.

Politics and Power Loads

IT is an interesting fact that electric lighting loads in metropolitan areas increase many hundred percent during the President's "Fireside Chats." The additional load is divided between the increased number of radio receivers and electric lights turned on during these periods.

Apparently the power companies can gage to a nicety the radio audience of any program of national interest, but it is doubtful if the power load curves could serve as the basis of a straw vote; for one thing, the average farmer owns a battery-operated receiver. . . .

Ten Meters

IF your all-wave receiver tunes down to ten meters, it will be well worth your while to listen in frequently at that amateur band. It extends from 28 to 30 megacycles, but only that part from 28 to 29 megacycles is provided for use by amateur radiophone stations.

This is by no means a new amateur band, but it has been comparatively inactive until recently. Now it is a very active band, and it is not uncommon for an amateur 'phone station to contact all continents in a single day.

The band is unreliable in the sense that some days only transmissions from United States amateur stations can be heard, whereas on other days the whole world may come pouring in. Like the little girl with the curl hanging down on her forehead, when the band is good, it is very, very good; when it is bad, it is horrid.

But ten meters packs enough thrills to satisfy any person with sufficient patience to wait for the good days when the band is "wide open." It is distinctly a "daylight" band; therefore listening should be done before nightfall.

Receiver Alignment

FEW radio receivers can maintain perfect alignment of tuned circuits over long periods of time. If sensitivity and tone quality are to be maintained, re-alignment at fairly regular intervals is desirable.

It is not easy to determine when a receiver is out of alignment. The change in circuit values is usually so gradual that the listener is not aware of the drop in sensitivity or the alteration of tone quality. A condition of this sort can be detected only through the use of radio servicing equipment; the ear is not sufficiently precise.

Noise Silencer Adapters

A BRIEF explanation of the Lamb Noise Silencer appeared in these columns in the April issue of *Scientific American*. Since then, a number of companies have placed on the market noise silencer adapters suitable for use in conjunction with the average type of superheterodyne receiver.

One type of adapter is designed for use with a receiver having but one stage of intermediate-frequency amplification; another type is made especially for a receiver having two stages. It is highly important that the correct type be used, as the adapters are not interchangeable.

It is also important that the intermediate frequency of the transformer used in the adapter be exactly the same as the intermediate frequency of the receiver with which the adapter is to be used.

The adapters will not silence all man-made static, but they are of great assistance nevertheless. After a bit of practice, the average listener should have no difficulty in operating one satisfactorily.

Air Conditioning

By J. A. Moyer and R. U. Fittz

HERE for the first time in one volume is a complete treatise. The first half of the book covers theoretical fundamentals and discusses such phases of air conditioning as air filtration, refrigeration, humidity control, and so on. The second half gives a thorough study of design requirements, including such features as examples of typical air conditioning designs with the necessary calculations for theaters, restaurants, food factories, textile mills, and so forth, also giving attention to recent advances in household, office building, railroad train, and theater applications.—$4.20 postpaid.

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 279)

field, and, having done this, to operate an alarm system of some type the instant this field is penetrated or disturbed by the presence of a human body attempting to enter the protected area. Although the action is immediate and absolutely foolproof, the field thrown from its antenna system is harmless and cannot be detected by the intruder.

The control mechanism is installed within the protected area, generally in the cellar or in a closet. Antenna wiring is run to openings or areas it is desired to protect and from this antenna the sensitive "radio" field is generated only where desired. Installation of the antenna wiring may be completely concealed, as the generated field readily passes through wood, glass, tile, and so on.

When the system has been turned on and is in operation, protection exists regardless of whether windows or doors are open or closed, and immediate warning is given *before* the criminal has entered. Frightening the marauder before rather than after he has gained entry, gives the greatest possible protection to the members of the household, as the criminal trapped within the home is a highly dangerous individual.

Fireproofing Cotton Duck

THE use of cotton fabrics for awnings, tents, canopies, wagon and stack covers, and for other out-of-door purposes has always been accompanied by fire hazards. Also, the danger from fire exists elsewhere and was instrumental nearly a generation ago in leading the English chemist, William Henry Perkin, to make a search for a way to fireproof flannelette which was widely used at that time for children's clothing. This chemist discovered the fireproofing properties of tin oxide and widely publicized the possibility of fireproofing clothing by impregnation with this oxide. Many of his claims were not substantiated in practice and his treatment never attained wide use.

Water will not remove tin oxide from cotton cloth and it would seem that treatment with tin oxide would be excellent for awnings, tents, and like articles. Unfortunately, tin oxide only flameproofs the fabric and at the same time actually increases the tendency of the fabric to smolder. In fact, an awning treated only with tin oxide would burn up just as surely, if a lighted cigarette butt was dropped on it, as would an untreated awning, although no flame would be apparent.

Another fault possessed by the tin oxide is that it causes the fabric to lose its strength when exposed to the sun. At the end of one season the treated fabric would scarcely support its own weight because of this effect.

The Bureau of Chemistry and Soils has found that certain pigments can be put into the fabric which will retard this rotting effect of the tin oxide. Just as important, they also found a way to increase the efficiency of the flameproofing effect of tin oxide so that now only 5 to 10 percent of tin oxide need be used instead of 15 to 20 percent as was necessary with the Perkin's process. This is important because tin is an expensive metal.

The Bureau also developed a new chlorinated resin which is especially suited for use on fabric in connection with the pigmented tin oxide. This resin prevents the smoldering tendency and thus the combined effect yields a fully fireproofed fabric which lasts longer in out-of-door service than untreated fabric.

The complete process including the production of chlorinated resin is being put on a commercial basis as rapidly as possible.

The advantages of such a treatment are obvious. There is absolutely nothing that can be washed out of the fabric and consequently the fireproofness remains throughout the life of the fabric. The usefulness of canvas for awnings, tents, salvage covers, implement covers, and so on, is greatly extended as a direct result of permanent fire-resistance. Aside from use which industry and the farmer may make of fire-proofed canvas, increased use of cotton will react indirectly to the benefit of the cotton farmer and the cotton goods manufacturer.

Rubber Joints for Concrete Roads

RUBBER joints for concrete roads may open an extensive new market for rubber if present trials in New England continue to prove satisfactory, says Arthur D. Little's *Industrial Bulletin*. One of the constant troubles with concrete roads is that the asphalt filler for expansion joints is forced above the road level when the road expands and does not recede properly when it contracts. Hard ridges are created which provide rhythmic but unpleasant bumps for the traveler, and the spaces from which the ridges came are eventually filled with water. The damaging effect of water expanding to ice in such confined spaces is well known.

Rubber latex compounds of a creamy consistency that vulcanize in two weeks to a compressible elastic mass have been found to overcome many of the difficulties encountered with asphalt. Labor costs on the maintenance of the present asphalt joint are so great that a rubber latex-bond cost of the order of 1200 dollars per mile for each lane of road is apparently a net economy. Experiments have been conducted over a period of more than two years, and while it is still too early to make predictions, apparently no serious drawback has been found, and both road engineers and rubber men are following the method with interest.—*A. E. B.*

"Jumpy" Screen Makes Smooth Movies

YOUR favorite "movie" actor and actress will be made to perform in front of a "jumpy," or, rather, vibrating screen during the "shooting" of scenes if the motion picture producers adopt the method for making more perfect "movies" recently perfected by Willis H. O'Brien, of Los Angeles, Calif. The jumpy screen actually makes a "smoother" picture.

The invention is for use in making composite scenes. These scenes eliminate the necessity for companies to go on location

when they already have available in their film library pictures of the desired background.

In this method of making movies, if a Paris, New York, or jungle background is required, the director selects a film of such a scene from the film library and uses a projecting camera to throw it on the back of a huge ground-glass or equivalent translucent screen. On a set in front of this screen the actors perform while the movie camera simultaneously "shoots" the actors and the scene projected on the screen.

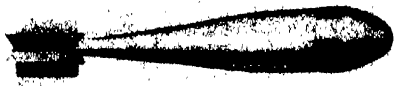
When the film is developed and shown on the usual screen, the effect is the same as though the scene was taken in the locale of the background. However, any defects in the background screen that show up in enlargement, such as grain and irregularities, may spoil the effect. Inventor O'Brien has found out that he can literally shake these defects out of the picture by vibrating the ground glass screen during scene "shootings." This is accomplished by suspending the screen from two springs so that it can slide up and down in guide grooves in two vertical supports, and then vibrating it with a cam turned by an electric motor.

Brazed Tear-Gas Projectile

In the manufacture of a new long-range projectile for use with tear or nauseating gas, the Lake Erie Chemical Company has adopted electric-furnace brazing as the most (and probably the only) practical method of providing five strong, gas-tight joints between seven important main members of the assembly.

Soldering and torch-brazing were found unsuccessful because it was necessary to

Above: **Gas gun and cartridge.** *Below:* **Projectile that is made gas-tight by electric-furnace brazing**



obtain joints which would withstand high gas pressures without leaking and because the design of the shell embraces certain small, complicated parts having surfaces that are difficult to reach. Electric-furnace brazing in a controlled furnace atmosphere, a process developed by the General Electric Company, is making it possible to fabricate the shell with joints that are absolutely tight and able to withstand pressures of more than 3000 pounds per square inch. In one test, the shell failed at a pressure of 3300 pounds per square inch, but the brazed joints remained sound.

The brazing is accomplished in a 20-kilowatt batch-type electric furnace operated at 2100 degrees, Fahrenheit, and used in conjunction with a combustion-type furnace-atmosphere controller. The latter reforms a mixture of natural gas and air, supplying a reducing atmosphere which acts as a flux for the brazing metal. The shell parts, assembled with copper wires tightly wound at the joints, are laid on trays and placed in the heating chamber of the furnace for 15 minutes. The copper flows into all parts of the joint by capillary action, and the process is completed by passing the work into the cooling chamber of the furnace, where it remains for an hour during which its temperature is reduced to about 200 degrees, Fahrenheit.

The shells thus manufactured are approximately nine inches long and an inch-and-a-half in diameter. Loaded in a cartridge and fired from a 37-millimeter shoulder gun, they have a range of 500 yards and may be sent through a window at 100 yards. In appearance, they resemble an aerial bomb, being shaped like a torpedo and having a finned tail. When a rapidly moving shell of this type strikes a solid object, a percussion cap is set off, firing an explosive charge which bursts the shell and liberates the compressed gas.

Because of its long range and the accuracy with which it can be directed, the new projectile may be used to advantage by police officers. For example, when attempting to capture criminals barricaded in a building, instead of exposing themselves to gunfire, as might be necessary with commonly used hand-thrown grenades, the officers will in many cases be able to fire the new projectile into the building from a position of safety, thus overcoming the criminals with the gas and making possible their capture.

Spare the Heat— And Save the Meat

Cook meat at moderate temperature, says the Bureau of Home Economics. Meat is a protein and, like white of egg, is toughened and hardened by long heating at high temperatures. Broil, roast, or fry tender, well-fattened cuts from young animals, in an uncovered dish without water. Braise, simmer, or stew less tender, leaner cuts with a cover, with or without water.

All cuts of pork, lamb, and veal are tender. Pork and lamb are fat enough for roasting and broiling. Veal usually is fat enough only for braising—generally with a little liquid added.

The less connective tissue there is in beef—the more tender it is. Tougher cuts are made tender if cooked as pot roasts, "smothered" or braised steak, or stew, or if ground or chopped and cooked as tender meat in hamburg steak or meat loaf.

To pan-broil tender steak or chops, brown both sides in a lightly greased, sizzling hot skillet, lower the heat and cook slowly, turning the meat to insure even cooking. Pour off accumulated fat or the meat will fry. Never cover or add water in pan-broiling.

How many minutes per pound a roast takes depends mostly on oven temperature and whether the meat is to be rare, medium, or well done. A standing beef roast, seared for 20 minutes in a hot oven (about 500 degrees, Fahrenheit) and finished in a moderate oven (about 300 degrees, Fahrenheit) usually is rare in 16 to 18 minutes to the pound, medium in 22 to 24 minutes, and well done in 30 minutes. Rolled roasts take from 10 to 15 minutes more per pound than standing roasts. The only sure guide, however, is a roast-meat thermometer inserted into the thickest part of the meat. Beef is rare at about 140 degrees, medium at about 160 degrees, and well done at about 180.

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THE 200-INCH TELESCOPE

(Continued from page 240)

available site for the 200-inch telescope. After many tests, extending over several years, Palomar Mountain, in San Diego County, has been selected. Here, on a tract of about 600 acres, several structures have already been erected, under the general direction of Captain Clyde S. McDowell, U.S.N., Supervising Engineer. These include large storage tanks for water and gasoline, a pumping and distributing plant, a dwelling house, and so on. The site for the 200-inch telescope dome has been levelled, and it is hoped that foundations for the telescope and dome, as well as the lower (fixed) part of the building, can be erected during the present year.

Every large telescope, if efficiently used under good atmospheric conditions, not only adds to our knowledge of existing problems but reveals new ones for solution. Thanks in part to increased light-gathering power, and to the development of new auxiliary apparatus, the volume of space opened up for investigation may prove to be fully 50 times as great as that partially explored in 1928.

It goes without saying that all observatories, large or small, should have a well defined scheme of research. The Astrophysical Observatory of the California Institute will deal with the investigations for which it is especially adapted, in harmony with the observational and theoretical work of the Mount Wilson Observatory and the various departments of the California Institute. In view of its great light-gathering power, one of the most important tasks of the 200-inch telescope will be the study of the structure and radial motion of the extragalactic nebulae, especially in their bearing on the still open question of the nature of the "expanding universe". The nearer large spirals, such as the Great Nebula in Andromeda, offer many problems for detailed examination, while the Galaxy, within which we live, presents scores of questions awaiting their turn for study with powerful instruments.

Take, for example, the critical analysis of the brighter stars. Ever since I began work at Kenwood with a ten-foot Rowland grating, I have felt hampered by the comparatively low dispersion of the spectrographs ordinarily used for the study of stellar spectra. In fact, my chief incentive toward the construction of larger telescopes 40 years ago lay in the possibility of obtaining stellar spectra of high dispersion, comparable with that used in those days only on the sun. High dispersion has since been realized at the coudé focus of the 100-inch Hooker telescope, and the 200-inch should permit us to take another step in the same direction. Its increased light-gathering power, aided by the new types of spectrographs recently devised here, should be especially serviceable.

If such research problems as I have mentioned lie chiefly in the field of astrophysics, it should not be forgotten that the new observatory may also play an important part in the field of pure physics. Scores of physical questions await attack in an observatory, simply because the conditions of high temperature or of extremely low or extremely high masses and densities encountered in many celestial objects cannot be duplicated in the laboratory. As chemical questions are also involved, it is evident that the new observatory may be expected to contribute materially to several branches of science.

Cosmic Rays Thus Far

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By Edward R. Weidlein and William A. Hamor

"DURING Walks and Talks in Mellon Institute" is the sub-title of this volume and while it appears to be just that—a collection of essays written at various times—it has been extremely well done and the various pieces so well organized as to make a most readable book. Some of the sections, each covered by several features, are as follows: Industrial Research Procedure of Mellon Institute; Industrial Research Successes and Opportunities; Professional Aspects of Industrial Research; Questions in Industrial Research Management; Literary Activities in Industrial Research; and there is a final section on the Progress of American Chemistry since the Outbreak of the World War. This discussion should prove valuable to those now engaged in, or desiring to do, industrial research.—$2.90 postpaid.—*F. D. M.*

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By J. G. Crowther

TO understand science, it is necessary to work back into its roots. More than any others, five great men of science living in one century, the 19th, have altered our lives and outlook. These were Davy, Faraday, Joule, Thompson, and Maxwell. This book, whose author occasionally writes for the Scientific American, is not merely a set of biographies of these men but it also traces the direct significance of their discoveries on life today.—$3.65 postpaid.—*A. G. I.*

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THE same comments given for Volume I, reviewed above, apply also to this book which deals specifically with such phases of applied physical science as the properties of liquids, heat and cold, light, electricity, and sound.—$1.65 postpaid.—*A. P. P.*

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By Henry Albert Phillips

WHATEVER may be our personal feelings regarding the present political activities in Germany, reasonable human beings will admit that there must be a Germany which has been obscured to a great extent by the larger, much featured issue. Mr. Phillips, a trained observer in foreign lands who has written other successful books of this sort, gives us an insight into part of the truth about Germany today. He understands the uses and abuses of propaganda and passes that aside in getting at the meat of his story. After discussion of the transition from the old to the new Germany, he carries on to a discussion of Naziland,

as he calls it, of youth marching with banners continually, of the labor camps, Communism, kultur, of the neo-paganism, and finally ties this in with Borderland Rumbles, or the influence upon neighboring countries. Neither he nor anyone else can predict the future for Germany so he simply ends with a chapter "Where Do We Go From Here?" Nevertheless, his discussion is provocative throughout.—$3.15 postpaid.—*F. D. M.*

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A SURVEY of the present position of the petroleum industry, and its outlook toward the future, published by a noted organization of oil men. Demand, production, supply, transportation, refining, marketing, taxation, labor—these are the main aspects discussed. The rumor, once more rampant, that our oil supply is almost exhausted, is once more knocked down. A good book for the reader who wishes to keep up to date about the oil industry in general. 200 pages, cloth binding.—65c postpaid.—*A. G. I.*

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By James C. Kinkaid

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THE PHENOMENA OF LIFE

By George Crile, M.D.

THE noted Dr. Crile, of the Cleveland Clinic, sets down in this semi-popular book the basis for his hypothesis that electricity is the basis of life. Oxygen, he says, produces radiant energy, this generates electric currents in protoplasm, and the normal and pathological phenomena of life are manifestations of protoplasm, hence life must be due to radiant and electrical energy. This hypothesis has not yet been accepted by science, but its discussion makes fascinating reading, and Dr. Crile's standing in the world of medicine is high.—$3.70 postpaid.—*A. G. I.*

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By Kenneth A. Hathaway

HERE is a well written discussion of the underlying principles of radio communication as it stands today, presented in general form and avoiding completely the use of specific equipment for explanatory purposes. This is one of the best books that we have ever seen for supplying a background of knowledge of a specific subject, without overburdening the reader with unnecessary side issues. The author has built up the text admirably by first describing the separate functions of various instruments and then showing how these functions are coupled to achieve a desired purpose in a completed circuit.—$2.15 postpaid.—*A. P. P.*

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By August Hund

RESEARCH workers, serious-minded students, and teachers will find in this reference book a thorough discussion of high-frequency phenomena applied to measurements. The subject matter is strictly up to date both as to theory and practice. Anyone who has the necessary background and equipment for carrying on high frequency measurements or research work in this field will find this thorough-going volume of inestimable help. It has a splendid index. 642 pages, 6 x 9 inches.—$6.25 postpaid.—*A. P. P.*

THE PRACTICAL ASPECTS OF PSYCHOANALYSIS

By Lawrence Kubie, M.D.

READERS with some—though not necessarily large—background with regard to psychoanalysis, also general practitioners in medicine, may use this book as a help or guide in getting hold of the right kind of psychoanalyst rather than some of the "pseudo" kind who have pinned the label psychoanalyst on themselves, much to the confusion of the public and the detriment of psychoanalysis. It also contains a list of accredited psychoanalytic societies. The author is a member of the College of Physicians and Surgeons at Columbia University.—$2.15 postpaid.—*A. G. I.*

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By Orville Adams

DIESELS are so rapidly coming to the fore that numerous books concerning them are being published every day. Here is one which gives fundamental information concerning stationary, marine, locomotive, and automotive Diesels and goes into the question of their engineering quite thoroughly. We might say that a study of this book would be the first step toward a complete understanding of the principles of Diesel engines, of the equipment that must be designed for them, and of the fuel they use. Many illustrations serve to make the discussion more lucid.—$4.25 postpaid.—*F. D. M.*

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COVER

OF importance to research in smoking, as discussed in the article "If You Smoke" in this issue, is the cigarette puffing machine shown on our front cover and described in detail on page 355. This simple yet efficient machine, illustrated through the courtesy of Philip Morris Ltd., was designed by Doctors Michael G. Mulinos and Raymond L. Osborne of the Department of Pharmacology at the College of Physicians and Surgeons, Columbia University.

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50 Years Ago in . . .

Scientific American

(Condensed From Issues of June, 1886)

PASTEUR—"Up to April 14, Pasteur has inoculated 688 persons, presumably bitten by mad dogs, with only one death. He has also inoculated 19 Russians bitten by a mad wolf. Of these 19, three have died from hydrophobia—about 16 percent. The usual percent of deaths from the bites of mad wolves is said to be about 67. Pasteur has found that the rabies resulting from wolf bites is the same as that of dogs, and only more dangerous because the bites of wolves are more numerous and severe."

"AIR CONDITIONING"—In a case of typhoid fever "a number of tubs were placed in the room, and kept filled with ice, and the doors kept closed. The temperature of the room sank to 80° or less, an average of 12° or 15° below the temperature of the other rooms in the house; and the cooler atmosphere not only added to the comfort of the patient, but aided in keeping down the body temperature, and materially contributed to a final recovery."

ALUMINUM—"A cubic foot of aluminum weighs 166 pounds, while the same bulk of tin will weigh 445 pounds. The uses of aluminum are indeed unlimited, even when it is produced at $2 a pound, as may be easily conceived from its many valuable properties."

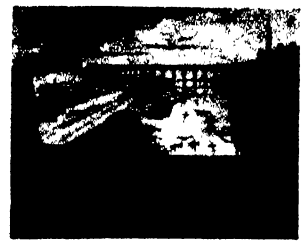
SPHINX—"For some months past, excavations have been carried on at Ghizeh, near Cairo, with the view of freeing the famous Egyptian Sphinx from the masses of sand which have gradually buried the monument. M. Maspero, the Director of the Boulak Museum, has superintended the operations, which have proved remarkably successful, and in a recent letter he states: 'The result is beyond all my hopes. The face, raised fifteen meters above the surface, is becoming expressive, in spite of the loss of the nose. The expression is serene and calm. The breast has been a good deal injured, but the paws are almost intact. We have nearly reached the limits of the diggings of Mariette and Caviglia. The work now going on is in beds of sand, which have not been disturbed since the first centuries of our era.' Later he writes: 'The stones of the right paw are covered with Greek votive inscriptions, while the left have none—an indication that the piety of the faithful was called into play more on the south side.'"

ELECTRIC LIGHT—"With a view to put at rest the question whether local electric lighting companies are profitable investments, we have recently addressed a circular letter to the general managers of a number of such companies. We have received answers from all parts of the country, and the general tenor of the replies is that many of their local companies are earning better dividends than are yielded by the majority of other new enterprises."

BALLOON—"A new dirigible balloon, says the *Deutsche Heeres-Zeitung*, is 150 meters in length and 15 meters in diameter, with a capacity of 18,000 cubic meters, about ten times as great as that of the Renard and Krebs balloon. The propelling machinery consists of two steam engines of 50 horsepower each. The cost is estimated at 100,000 marks ($50,000)."

WOOD WOOL—"Wood wool was first introduced into France as a packing material. It weighs about 40 or 50 percent less than the materials generally used for such a purpose. Its beautiful appearance, its fineness, and its extreme cleanness at once brought it into favor with shippers. It was afterward found that the material was well adapted for the manufacture of mattresses, for bedding for cattle, for the filtration of liquids, and for stuffing horse collars, etc."

AQUEDUCT—"Perhaps the most interesting and novel feature of the great aqueduct now being built by the city of New York to increase its water supply is that portion of the tunnel extending beneath the Harlem River. The contrast between the old and the new methods of crossing this river has been happily brought out by our artist. High Bridge, over which the present supply comes, shows in the background; the foreground being occupied by the section through the bed and banks of the river, far below the surface of which the new aqueduct is to pass."



NEWSPAPERS—"The wonderful growth of American newspapers is shown by a comparison between the directories published in 1776 and in the present year. The one contains in its sixteen small pages a list of 37 newspapers which were published in this country one hundred and ten years ago. The other is almost as large as an unabridged dictionary, and in its two thousand pages contains the names of 14,160 newspapers and periodicals of all classes."

LIFEBOATS—"During the last meeting of the Institute of Naval Architects, the question of using steam lifeboats was made the subject of a very interesting and useful discussion. Messrs. Benjamin and Taylor have designed a very ingenious steam lifeboat, and they read a paper describing it, and exhibited a model. The boat in question is, of course, intended to be unsinkable, and, as we understand the description, she is also to be uncapsizable."

MACHINERY—"Those who entertain the opinion that the possibilities of labor saving machinery are nearly exhausted are greatly mistaken. In the hands of the modern scientific inventor, matter becomes almost miraculously endowed with life and intelligence, and with great accuracy performs those functions which the most skilled manual labor executes but slowly and imperfectly."

COMETS—"The new comet just announced by Professor Brooks makes the ninth that he has discovered during the past five years. It is the third comet discovered this year, and, with the last one announced in 1885, makes four comets in succession detected by this one observer."

GUNPOWDER—"The advances made within the past two or three years in the manufacture of gunpowder for heavy ordnance have been very great . . . due to the development of more perfect mechanical devices for the necessary processes."

AND NOW FOR THE FUTURE

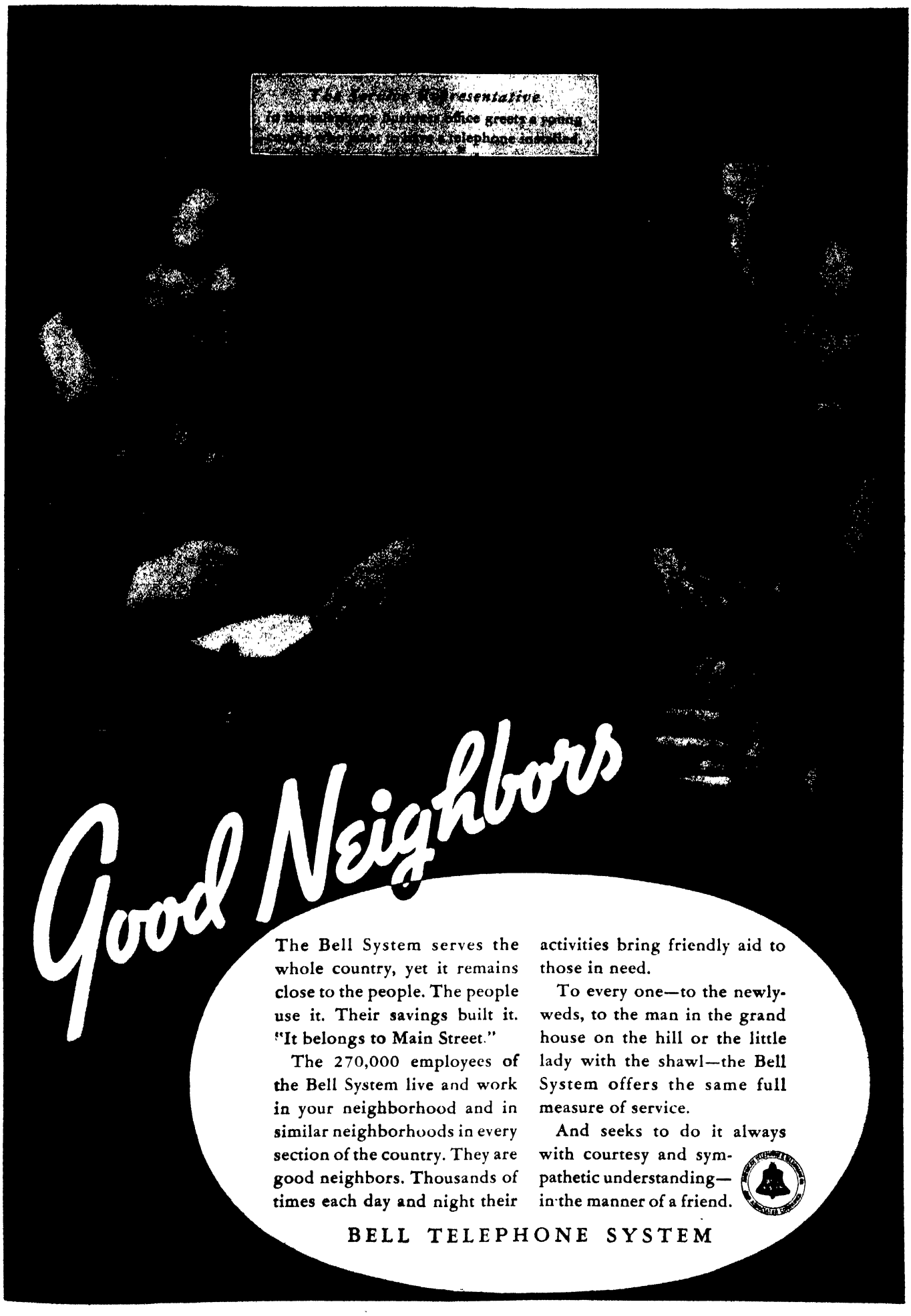
¶Unraveling the Mystery of Machine Tool Design, by Philip H. Smith

¶Polar Molecules: What They Are, What They Do, and Why, by Sidney J. French

¶Misinterpreted Animal Observations, by S. F. Aaron

¶Cutting Metals Underwater With the Electric Arc, by R. G. Skerrett

¶Ingenious Machinery Used on the Colorado River Aqueduct, by Andrew R. Boone



The Bell System serves the whole country, yet it remains close to the people. The people use it. Their savings built it. "It belongs to Main Street."

The 270,000 employees of the Bell System live and work in your neighborhood and in similar neighborhoods in every section of the country. They are good neighbors. Thousands of times each day and night their activities bring friendly aid to those in need.

To every one—to the newlyweds, to the man in the grand house on the hill or the little lady with the shawl—the Bell System offers the same full measure of service.

And seeks to do it always with courtesy and sympathetic understanding—in the manner of a friend.

BELL TELEPHONE SYSTEM

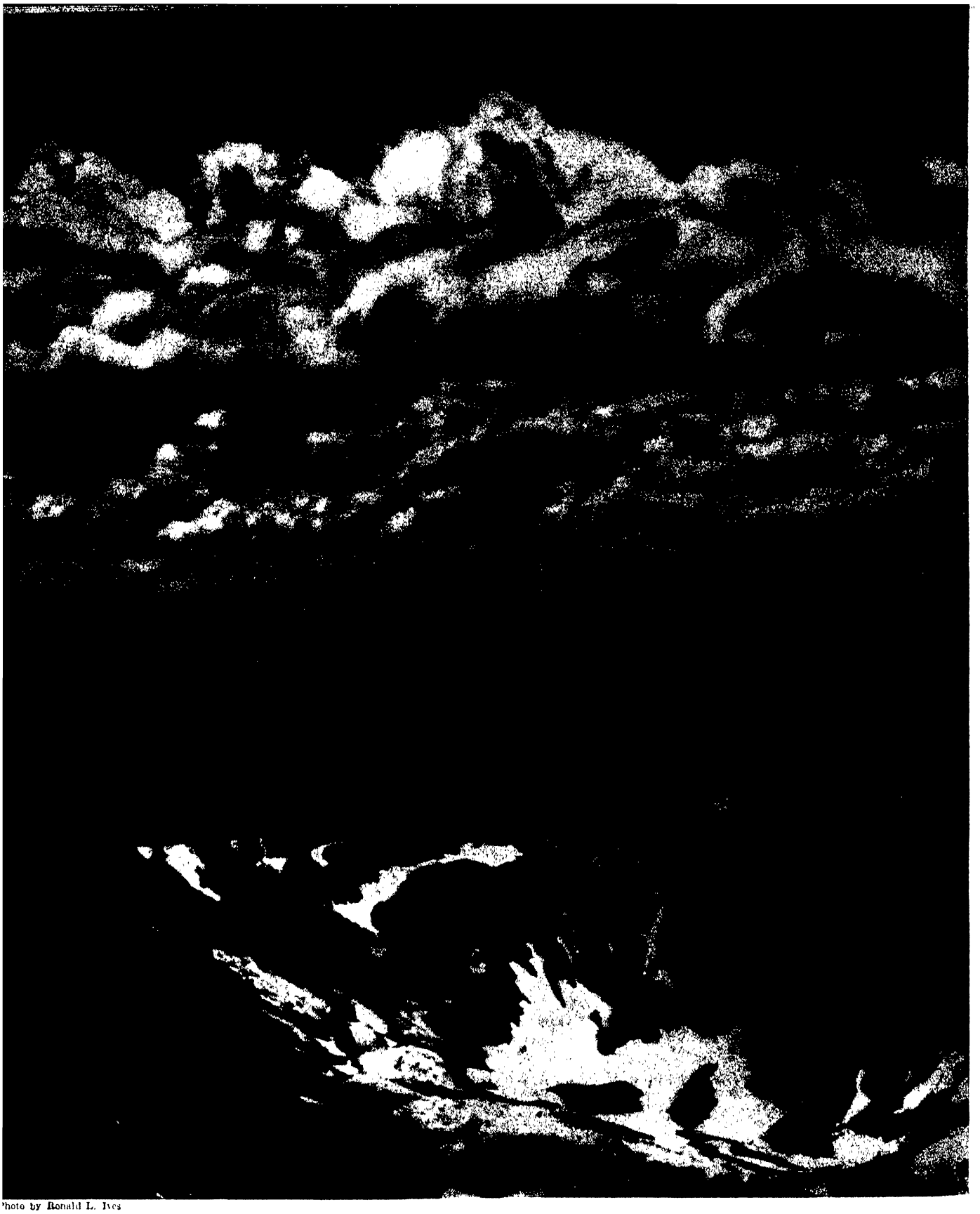


Photo by Ronald L. Ives

INFRA-RED REVEALS NEW BEAUTIES OF NATURE

INFRA-RED photography, coming into wider use as its merits are more fully appreciated, has been employed in this case to give a striking view of the mountain ranges of central Colorado. The camera was set up on Arapaho Peak; through the notch to the left of the center of the photograph shows Pyramid Peak, 120 miles distant, in the Elk Range. The mountain ranges shown are the Blue and Mosquito in the center ground, and the Sawatch, Gore, and Elk through the gaps in the skyline.

Photo by Geoffrey Landsman

Figure 1: Removing the inscribed street-corner altars from Temple *A*

THE ROAD TO EMPIRE—I

Ancient Minturnae, an Early Roman Town, Stood in the Way of Rome's Great "Lincoln Highway" . . . Excavations Reveal the Type of Roman Life

By JOTHAM JOHNSON
University Museum, Philadelphia

OUR Italian expedition was something of a surprise to all concerned.

We left New York vaguely expecting to excavate Stabia, which was destroyed by the eruption of Vesuvius in 79 A.D. together with Pompeii and Herculaneum. Italy had offered us a concession there, and on our arrival in Naples we were solemnly escorted to one of the finest vineyards in southern Italy, where abortive excavations a century ago had located a few buildings under 30 feet of volcanic ash.

Anyone who wants to dig Stabia will have to lay out most of his first year's budget for real estate. That was bad. Besides, I had felt all along (with many colleagues) that enough Pompeian art had already been found to satisfy every taste. It was clearly up to Italy to suggest an alternate site.

Italy mentioned Minturnae, and we motored out to see it. Minturnae lies in a checkerboard of wheatfields and vineyards, 50 miles north of Naples, along the Mediterranean coast, near the mouth of the River Liris. Its identity has never been lost. The ancient theater and the aqueduct rise conspicuously beside the motor road, and farther back we noticed the ruins of two temples and an amphitheater. I judged that, in general, the ancient ground level could not be more than three or four feet down, in some places no doubt less. Easy digging for us, but easy digging also for all the treasure-hunters of two past centuries; in 1819, for instance, an Austrian general named Nugent had found a quantity of Imperial sculpture and inscriptions there, and other discoveries have served to keep the site from oblivion.

The little plain is shut in on north and east by majestic mountains, on the southwest by the sea. On the nearer hills stand a half dozen modern towns, white against the blue haze. We expressed mild enthusiasm, and returned to Naples in a gentle summer shower.

SO far I had succeeded in concealing the fact that I had never heard of Minturnae; I now hurried to a classical encyclopedia. A few facts stood out, handed down in the pages of the Roman historians.

The Ausones, alias Aurunci, were one of the earliest Italic peoples to colonize southern Italy. When seen through Roman eyes they were a tribe of the backwater—uncivilized, untrustworthy, unadjusted to Roman standards, fit only to be subjugated; yet to long generations of Greeks Italy had been known honorably by no other name than Ausonia.

They settled in the delta of the Liris and built three drowsy market-towns, Ausona, Vescia, and Minturnae. They lived peaceably on the meat and grain and wine they raised themselves, and on fish from the sea. In the malarial marshes below Minturnae they built a primitive temple to Marica, Goddess of Fever, and a few Greek traders opened agencies at the river mouth, which provided a tolerable harbor.

In 314 B.C. the Romans, bent on a career of southward conquest in Campania, found these three walled villages a brief stumbling-block. One market-day a few Roman soldiers disguised themselves as farmers, hid swords under their cloaks, and entered the towns. The signal given, they killed the gate guards and opened the gates. Other troops lying hidden in the nearby woods rushed in, and the Aurunci were wiped out, or so Livy tells us.

In 312 B.C. Appius Claudius surveyed the first stretches of the queen of highways, the Appian Way, and fortified it with walled cities every few miles, like raisins on a string, until it knocked

Figure 2: **Slave lists from the inscribed altars of Figure 1. These provided a fair "Who's Who" of the Roman community of Minturnae**

grimly at the door of Samnium, Rome's only remaining rival in Italy. Roman colonies were to Romanize the universe; so Rome had found the perfect pavement for her road to Empire.

As Rome's fourth citizen colony, founded in 295 B.C. on the Appian Way, Minturnae's real history began. A fort was built, a forum laid out with temple and shops, and the business of a city began. In 207 B.C. a river of blood flowed in the gate. In 191 B.C. the Temple of Jupiter and the shops were "touched from the sky," Livy's euphemism for "struck by lightning."

The city developed an important industry in iron. In 133 B.C., when Tiberius Gracchus was assassinated, a wolf slashed a sentry and escaped, and in the same year a slave uprising was put down handily: when 450 had been crucified the rest went back to work. In 88 B.C. Marius the Dictator, driven from Rome by his potent rival Sulla, escaped to the south only to be trapped in the marshes near Marica's temple. He was confined briefly at Minturnae, but a sympathetic magistracy released him and put him on board a ship bound for Africa. Later Cicero in his letters frequently mentions passing through the city, bound for one or another of his many villas. When Tiberius was in residence at Capri the soldiers and courtiers and messengers who shuttled between there and Rome stopped to revel in the inns of Minturnae. Then Minturnae became just another Roman provincial city, and survived until the Longobards destroyed it about 589 A.D.

This was not much, but it was something, and it was more than we know of most ancient cities. If pre-Roman Minturnae had vanished in 314 B.C. and no one today knows where to look for its sister cities, Ausona and Vescia —we were not likely to find it without an intense search.

The Roman colony, on the other hand, might prove to lie under the Imperial city, and might be worth digging; these primitive colonies were the laboratories where Rome, stifling in her own congestion, performed the experiments in fortification and city planning and sanitation which she could not carry out at home. In general they are so overlaid with later buildings that they make dull digging, but at Minturnae, in prospect at least, the sky was the limit; we might hope to find walls, temples, altars and sacrificial deposits, porticoes, shops, iron foundries, potteries, private dwellings—the whole dim spectrum of primitive Roman life.

I hastened to notify our prospective hosts that the University Museum would be delighted to excavate Minturnae, and a few days later we opened our first trench.

I won't set out to tell you all we found; Mr. Munn has point-blank refused me the next 50 issues of Scientific American. Some of our discoveries would concern students of Roman architecture and of ancient art; others are of more special interest in the field of Roman history, confirming, adding to, and frequently changing our earlier conceptions.

THAT first week, for instance, we dug around the two temples we had noticed on our first visit and named them *A* and *B*. Temple *A* belonged to the early Empire. It rose from the margin of a paved street which we later discovered to be the Appian Way, bisecting Minturnae from west to east. The block in which *A* stood had been the forum of the original Roman colony of 295 B.C., though it was some time before we were in a position to prove that.

At the beginning the colonists had been satisfied with a simple forum which contained only a small temple and a few unsanitary shops. Ashes covering their foundations told us that these buildings had presently been burned. All this we had already learned to expect from the pages of Livy, who mentioned that they were struck by lightning in 191 B.C. A hoard of coins which turned up under the floor of one of these ruined shops belonged to the years preceding 190 B.C., a welcome check on Livy's reliability.

After the fire (and this Livy neglected to tell us) the colonists pooled their forces for reconstruction. They replaced the temple with a great new shrine, dedicated to Rome's Capitoline Triad—Jupiter, Juno, and Minerva. Accordingly this was a triple-cella temple, the seventh such so far found in all Italy. No one regretted the lost shops; where they had stood the ground was leveled over, and presently a vast three-winged portico was built, enclosing the square on west, north, and east, with the temple in the open south end of the U.

In and around the foundations of these buildings we found the remnants of their decoration, molded and gaily painted terracotta tiles and plaques. From these we could gain an idea of the temple's heavy wooden superstructure which, like contemporary Roman temples at other sites, proved to be a pure derivation from Etruscan models and patterns.

The three-winged portico was a different story, because the idea of such a building had come from Greece to Italy only in the previous decade. We may suppose that sophisticated architects of the metropolis had learned how to handle it by 190 B.C., but the oldest one yet found at Rome is a century younger than the one at provincial Minturnae, which remains unique, a merry hodge-podge of Greek plan, Roman foundations, Greek columns, and Roman roof construction and terracotta decoration.

No one has ever seen anything like this Roman forum, as rebuilt after the disastrous fire of 191 B.C. and now completely excavated: it is one of the most diverting lessons in post-war archeology.

Imperial Minturnae was wealthy enough to lavish rich temples on all her gods, but in the 1st Century B.C. many of them still had to be content with modest street-corner shrines. Each was attended by a group of 12 pious slaves, who had the privilege of setting up an altar, carved with their names, each year.

About 50 B.C. another bolt of lightning struck the big temple and it went

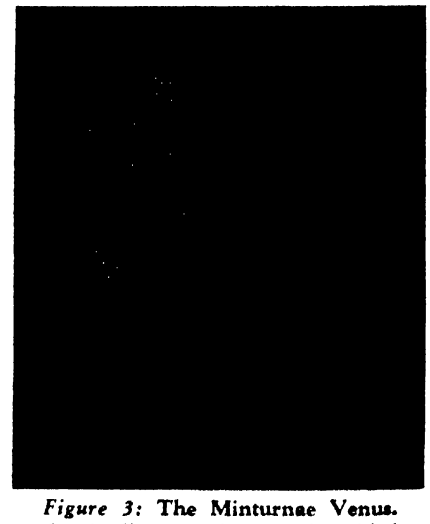


Figure 3: **The Minturnae Venus. Originally a ribbon of gilded bronze was used to "hold" the hair in this elaborate coiffure. The ears were pierced for earrings, now lost**

up in flames, taking the portico and a good deal more of the city with it. The forum was once more a heap of ashes. We'll come back to this next month.

In the new period of reconstruction which followed, room was found in the forum for Temple *A*, and 29 of these inscribed altars, damaged in the fire, were used to fill out *A's* foundations. We dug them out—Figure 1 shows us at

work; Figure 2 the result—and lined them up against a long wall.

When we had time to read the names we learned a lot of interesting things. Each slave gave his master's name as well as his own, and so we acquired a unique Who's Who of 200 citizens wealthy enough to own slaves, among them a C. Marius and an L. Cornelius. 'Sulla' was the cognomen, equivalent

Figure 4: **Portrait of a Roman gentleman. It is now at Philadelphia**

to a middle name, of L. Cornelius Sulla, and it is possible that the names on the stones belong to these great figures in Minturnae's history; it is also possible that they are mere coincidences. But the name of C. Titinius appears as a slave-owner in three places to prove truth in the Marius story, for during his sixth consulship Marius presided at a divorce suit between C. Titinius and his wife Fannia. He decided for the husband, and when he was captured at Minturnae he might have had opportunity to regret it, for he was imprisoned in Fannia's house; but the lady turned out to be magnanimous.

We searched for Fannia's name on the lists, but without success. We did, however, find cousins of the poet Vergil; and a Pirana whose name shows that her family came from Pirae, though that community was already extinct when Minturnae was laid out; and a Vitulanius, 'from Vitulanum,' whose name gives the dingy modern village of Vitulano near Benevento a hitherto unsuspected antiquity of 2000 years; and many more.

While all this was going on around Temple *A*, another gang was hard at work at Temple *B*. *B* was of concrete, a few years older than Temple *A*; I think it was built soon after Julius Caesar's death. We discovered many pieces of sculpture there; for a while I believed we had found an ancient museum, but that was before I knew what we were going to find elsewhere at Minturnae.

Some of the pieces lay within a few inches of the surface, and were grooved by plow-points; certainly modern treasure-hunters had passed this area by. The early Christians hadn't, though; they had burned the pagan temple and overthrown the false gods and smashed the portrait statues of the emperors, and left us to fit the pieces.

I identified an Aesculapius and a bust of Germanicus, and then a tree-trunk, with a fragment of leg attached, bearing the tantalizing inscription *Callimachus and Gorgias the Athenians made this.* One memorable day as I was sitting working in the office a workman came in carrying the lovely Minturnae Venus (Figure 3).

IN one corner of the sanctuary we came on a prostrate marble slab like a flat tombstone, but when we turned it over we read upon it the dedication of a memorial statue of Julius Caesar. We wanted desperately to discover at least the head of this statue. The best we could find was an unidentified head of appropriate date; it *might* be Caesar.

Along the east flank of Temple *B* was a concrete trough built to catch the drip from the temple's eaves, late in Minturnae's history. Under one end of this we caught sight of some fragments of terracotta sculpture, and since the trough was of little scientific interest we measured it, photographed it, and condemned it. Giuseppe Imperatore raised his pick high over his head and brought it down neatly into a vulnerable crack in the masonry. Out rolled a ghastly marble skull and lay there blinking up at us. Figure 4 shows it cleaned and mounted for polite exhibition in Philadelphia; if you had seen it that first minute, slimy and grey from its long incarceration, you'd never have forgotten it. And neither will I.

We were not neglecting our investigations into Minturnae's topography. In isolating Temple *B* we had ventured below the classical ground level, and at both north and south ends of the temple we had found the foundations of a massive wall of rough limestone blocks, much older than the temple straddling it. We stared stupidly at this for weeks before we realized that without conscious effort we had come upon a stretch of the fortification wall of pre-Roman Minturnae, the Ausonian town which Roman soldiers had sacked in 314 B.C. To the east of this wall lay the primitive fort, and looking a little more sharply we presently recognized the towers which marked its northwest and southwest corners. Later I spotted the foundations of the northeast corner tower in the bed of the Liris.

West of it lay the Roman colony of 295 B.C. We were surprised to find that this wall had continued in use after the Roman colonization, as a sort of partition between the halves of this curious double city. Figure 5 shows the junction of the two cities; to the left is the northwest corner tower of the pre-Roman wall of polygonal limestone masonry; the rest of the foreground is taken up by the ashlar wall which defended the Roman colony.

In the middle of the west wall of the early town we made one of our most interesting discoveries: the location of the main gate, to which Rome's highway to Empire was directed in 312 B.C. But, according to Livy, Minturnae lay deserted from 314 B.C., when the Romans wiped out the Aurunci, until 295 B.C. when the colony was founded. The Appian Way shows that it was inhabited in 312 B.C.; so, for once, we catch Livy in error. A few Aurunci did survive to carry down their old traditions.

Figure 5: **At the left is the ruined square tower from the earliest city wall, and at the right is a part of the wall built by Roman settlers, 295 B.C. See the text**

THAT MANTIS APPETITE

Gluttonous Praying Mantis . . . Ugly . . . Harmless to Humans . . . Beneficial . . . Devours other Insects

By PAUL GRISWOLD HOWES

NEARLY every insect that has been accidently imported into the United States from foreign countries has become either a nuisance or a real menace. Witness the ravages of the European corn-borer, the dreaded Japanese beetle, and a dozen others, in the attempted eradication of which the government and the states have already spent hundreds of thousands of dollars.

It is, therefore, interesting to find that the oriental praying mantis, which accidentally arrived in this country 30 or 40 years ago, and which has since excited a great deal of interest and comment, is one of the most highly beneficial and valuable insects in the world. (It belongs to the family *mantidae*, some species of which are indigenous to America.)

In the state of Connecticut, this insect was practically unknown in 1925. In 1926, one or two were captured, frightening their finders into telephoning for police aid. As each year passed, the mantids increased until now they are common objects in the months of September and early October.

Mantids possess enormous appetites for all other kinds of insects. They are very large creatures, measuring over four inches in length when mature; and their wings, when expanded in full flight, may spread over six inches. Their flight is powerful and they have been found crawling into windows of skyscrapers dozens of floors above the streets in New York City!

THEIR appetites—their stomachs if you like—are enormous, and they eat with the frankest bad manners, gluttony, and brutality. Look at the unfortunate grasshopper caught in the lightning-like gesture of the wicked forearms of the mantis. In an instant the victim is crushed and killed, and then, strangest of all, the mantis eats his victim for all the world like a human being eating corn on the cob!

These insects should never be killed. In a season they account for large numbers of foliage- and crop-destroyers. People should learn to recognize their curious egg cases also. In Connecticut, and doubtless in other states where the mantis has arrived, some people hunt for the egg masses after the leaves have fallen and place them in their gardens, where the new generations of mantids may feed upon harmful insects.

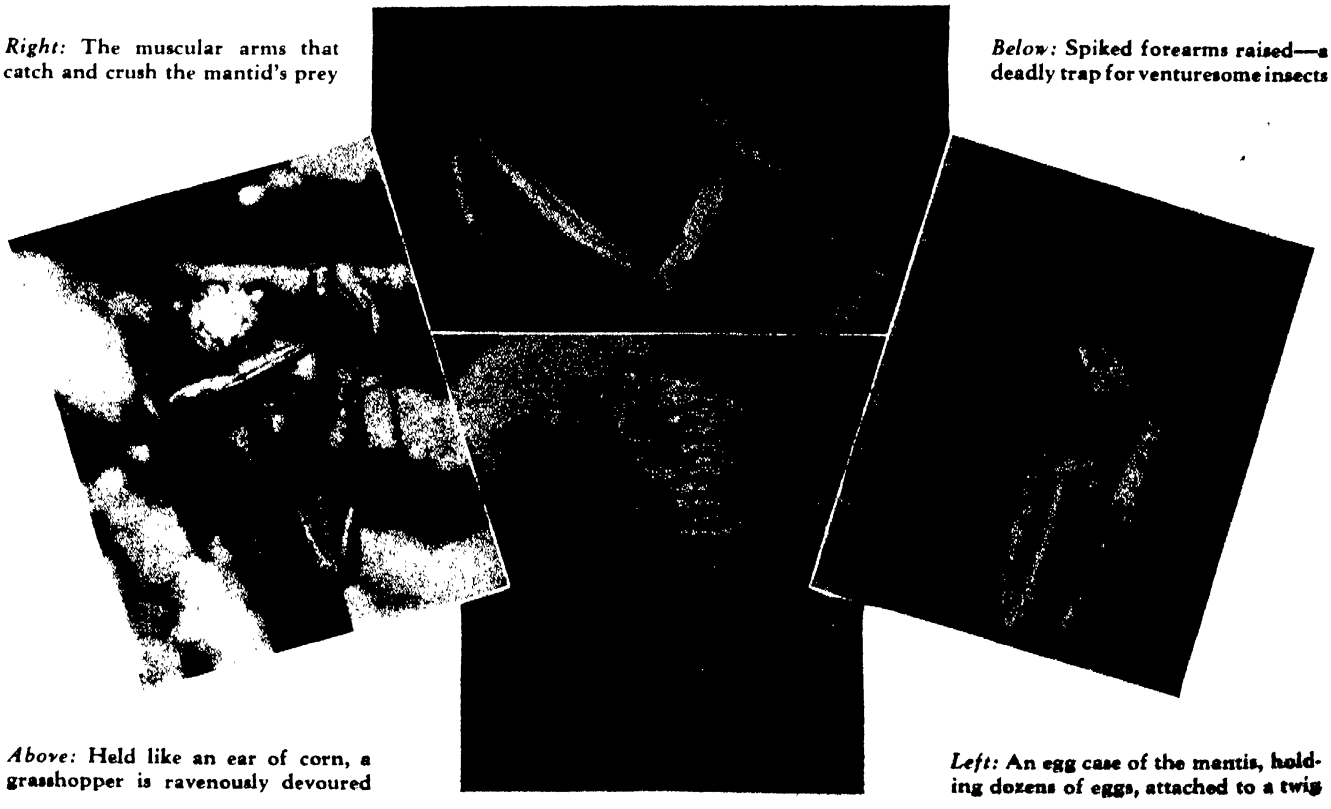
The eggs are deposited late in September or in early October. Inside the tough egg cases are dozens of elongated eggs which hatch the following spring. The young take most of the summer to mature, but from the very first they hunt out and kill every other insect in their particular neighborhoods.

When full grown in the fall, fighting appears to be a favorite pastime among the males and this, of course, is due in some measure to sexual rivalry.

Despite their violent natures, the mantids are entirely harmless to human beings. The more knowledge that may be spread in regard to them, the better it will be for our vegetation; and we should be thankful that for once a foreign insect so strong and ravenous has proved itself a distinct asset instead of a pest.

Right: The muscular arms that catch and crush the mantid's prey

Below: Spiked forearms raised—a deadly trap for venturesome insects



Above: Held like an ear of corn, a grasshopper is ravenously devoured

Left: An egg case of the mantis, holding dozens of eggs, attached to a twig

OUR POINT OF VIEW

New Naval Treaty

FROM amongst the welter of international arguments—the diplomacy that savors more and more of pre-war intrigue with its secret commitments and traded, selfish co-operation—there stands forth one more or less "open covenant openly arrived at." This is the new tripartite naval treaty, signed recently in London by representatives of France, Great Britain, and the United States. Even here there was some trading, but the negotiations showed so strong a desire among the high contracting powers to discover a workable agreement that concessions were almost eagerly made. The most unfortunate feature of the business is that Japan bluntly refused to consider a treaty after being denied her basic demand of parity with Britain and the United States, and walked out of the conference.

Perhaps the three most important provisions of the new treaty are: 1—There shall be no capital ships over 35,000 tons; 2—Cruisers shall not exceed 8000 tons; 3—Each contracting power shall give to the other two complete details of projected construction prior to laying down the keels. In addition, the treaty reclassifies certain types and specifies guns and armament. Thus no capital ship under 17,500 tons may be laid down or acquired prior to January 1, 1943. A like restriction is placed on capital ships whose main armament consists of guns of less than 10-inch caliber.

Aircraft carriers are apparently the only type, therefore, which may be built in the tonnages between 8000 and 17,500, but carriers must not exceed 23,000 tons. No submarine shall exceed 2000 tons standard displacement or carry a gun exceeding 5.1-inch caliber. To prevent what might be construed as an unfair advantage of one over the other, the treaty stipulates that, in time of peace, no merchant vessel shall be prepared for armament, except that decks may be stiffened to mount guns not exceeding 6.1-inch caliber. Emergency requirements of the national security of any one of the contracting powers, give that power the right—upon notifying the others and giving reasons—to lay down or acquire surface vessels of any standard displacement up to 10,000 tons. The same right may thereupon be exercised by the other two.

Limited though it be, the treaty is welcomed by all those who sincerely believe in the principle of limitation of naval armament by agreement among the powers. It is too bad, however, that Japan and Italy could not be induced to consider the problem fairly and lend their friendly co-operation. Suspicion is almost certain to be directed toward them. And, that, in a world already mad, might have, if not disastrous consequences, then at least the effect of increasing naval expenditures. The several naval treaties have sought to avoid just that. It is the general hope, therefore, that the "escape clause" of this latest treaty need never be exercised.

A Kingdom for a Book

IN 1921 John Mills wrote a book entitled "Within the Atom," that was destined to merited fame as the outstanding popular work—*the* popular book—on atomic physics. Every scientist remembers that book.

Alas, within five years it was largely out of date, and within ten years prehistoric. Now it is a museum piece—so rapid have been the strides of the physicists, leaving it far behind.

Though many a writer has tried his level best to "do a book" that would equally merit unstinted praise, none of the numerous attempts have seemed to win the same fame. Today, as far as first-class popular expositions on atomic physics are concerned, the world is bookless.

In other fields books may go on and on—Bertrand Russell's "ABC of Relativity," a contemporary of "Within the Atom," is still in the running, it too having been an outstanding exposition in its field. But relativity has kindly "stayed put," while atomic physics is as slippery as an armful of eels. Even a perfect book—*the* perfect book—might be out of date within the year.

Nevertheless, the world awaits such a book. What writer will gamble with fate?

Horns or Brakes?

REPORTS from England indicate that the "anti-horn" campaign inaugurated sometime ago as a safety measure for motorists is highly successful; a similar experiment has been tried in New York City and, while the ordinance is not very strictly enforced, the results are satisfactory enough to show the merit of the idea and to warrant its application in every community in the country.

"Anti-horn" campaigns have two definite objectives. First, they are aimed at a much-to-be-desired reduction in the noise level of our more congested areas, and secondly, at the safety of the motorist who all too often is inclined to rely more on his horn and less on his brakes to keep himself out of trouble.

It is trite to say that noise is one of the objectionable features of our mechanized civilization; recent studies by qualified investigators have pointed out, in a manner that cannot be refuted, the downright harmful effects of noise on the human nervous system. It is all very well for some people to say that they have become used to the noises that daily assail their eardrums, but they ignore or are not aware of the cumulative effect that these "unnoticed" noises have on their nerves and, consequently, on their general health. Thus, any local or state law that can control even a portion of the noise incident to motor travel is deserving of consideration, and should be given the whole-hearted support of the general public.

But even more important—at least from the dramatic standpoint—than the effects of noise on human beings, is the effect that "anti-horn" campaigns can and do have on the safety factor in motoring. These campaigns stress strongly the reliance that many motor-car operators place on their horns rather than their brakes. To see some of these drivers approach a crossing at high speed, sound their horns imperiously, and speed across the intersection without slackening in the least, makes one wonder how they ever lived to attain their present ages. Perhaps the answer is that they never happened to try this particular fool-hardy procedure at the same time and in the same place as another motorist with the same lack of regard for the rights and safety of others!

Horns have their places in motor-car driving; so have brakes. But when the driver substitutes the horn for the brake and expects the other fellow to keep out of his way, he is expecting too much of human nature. Once more we reiterate that automobile accidents can be reduced in numbers and in seriousness if drivers will remember that they are handling potential engines of death, that they do not have exclusive rights on the highways, and that they should show the same courtesy to others as they expect shown to themselves.

We offer a slogan: When in doubt, use your brakes—not your horn!

A Mountainous Earthen

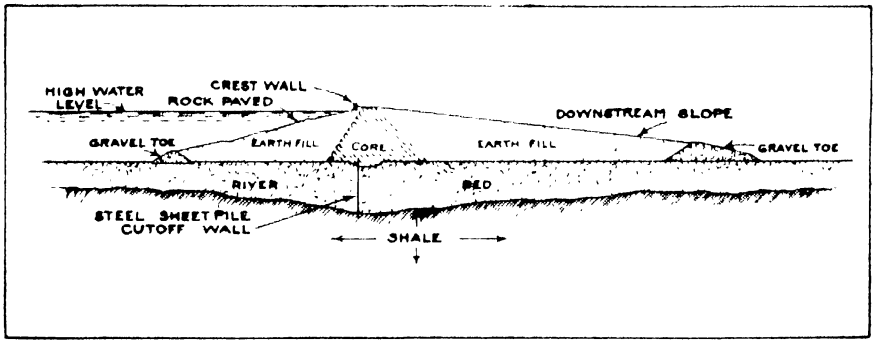
Fort Peck Dam . . . Aid to Navigation on "Big Muddy" . . . 100,000,000 Cubic Yards of Earth in the Dam . . . Unique Engineering Problems

By R. G. SKERRETT

WHERE dinosaurs wallowed one hundred million years ago in northeastern Montana, and a great inland sea then linked the Gulf of Mexico and the Arctic Ocean—splitting the continent, as we know it today, in twain—Fort Peck Dam is now under construction. The dam is to create a reservoir capable of impounding 19,500,000 acre-feet of water that can be released, when needed, to fill a navigable channel that is to make practicable modern water-borne traffic on the lower Missouri River between Sioux City, Iowa, and the mouth of that stream, a stretch of 768 miles.

The plan is to deepen that channel to eight or nine feet and to extend it up to Sioux City. The combined betterment will cost in the end probably more than 140,000,000 dollars, but it is estimated that such a channel will permit an annual movement of about 12,000,000 tons of freight at a saving of something like one dollar a ton. To keep such a channel supplied with water at certain low stages, a part of the spring floods must be conserved and released in sufficient volume to make up deficiencies during other seasons.

The reservoir above the Fort Peck Dam is the largest of the four that have been projected as a means of stabilizing the Missouri River and reducing its ravages when in flood. Its construction has been undertaken because of its magnitude and the fact that it would give unemployment relief to a large number of people in that section of the country. The working force has numbered 7200.



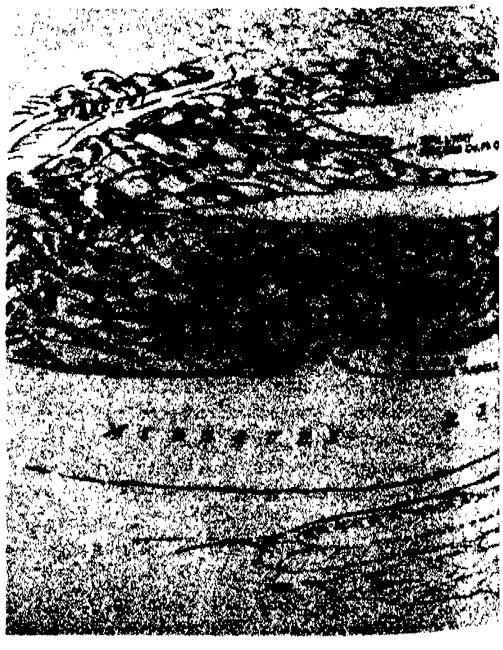
Transverse cross-section of the Fort Peck Dam. Note its various elements: earth fill, compacted core, gravel toes, rock paved upstream face, crest wall, cutoff wall

The Missouri River fluctuates greatly in the volume of its flow. At its low-water stage, it has discharged into the Mississippi as little as 12,300 cubic feet of water per second, while the maximum outpouring at flood stages has reached as much as 546,000 cubic feet per second. Droughts and seasonal abnormal rainfall and sudden melting of snow high on the slopes of the Rocky Mountains explain the wide differences in the height of the river which, at some points, may vary from 16 to 38 feet according to weather conditions.

During the last 30-odd years, many millions of dollars have been expended in improving the Missouri River between its mouth and Kansas City, a distance of 388 miles; at the present time there is a fairly stabilized channel having a general depth at low water of six feet.

The Missouri River has a length of nearly 2500 miles, a total fall of 3630 feet, and drains an area of 528,800 square miles. Throughout most of its length the river is a typical alluvial stream, characterized by instability of channel, relatively steep and frequently changing slopes, easily eroded bed and banks, and an enormous quantity of suspended material and bed sediment. It is, therefore, easy to understand why the river has become familiarly known as the "Big Muddy." Property losses due to erosion and inundation yearly total an equivalent of several millions of dollars. Such are the principal reasons for rearing the Fort Peck Dam which, with its initial appurtenant features, will entail an expenditure of 84,200,000 dollars, according to the estimate of the Corps of Engineers, United States Army, under whom the great undertaking is going forward.

BECAUSE of happenings in the long past, the damming of the Missouri in northeastern Montana has presented a complex problem both to the men that designed the dam and to their brother officers now in charge of its construction. The prehistoric sea that once occupied the region built for itself, in the course of eons, a sedimentary bed that survives today in the form of a firm stratum of clay shale that has a vertical thickness of fully 1000 feet. Two succeeding periods of glaciation cut and ground that formation as mountainous bodies of ice moved eastward during their dissolution. Then the Missouri River made other changes by carving for itself a fairly deep channel in the shale as that stream journeyed seaward. Subsequently, the river progressively raised its own bed by depositing water-borne sand, gravel, and silt upon the underlying shale until the accumulation attained its present depth of 160 feet and more. The adjacent flood plain, where not made up of aggregations of glacial till, is mainly composed of al-



DAM

luvial material placed there by the river when in its flood stages.

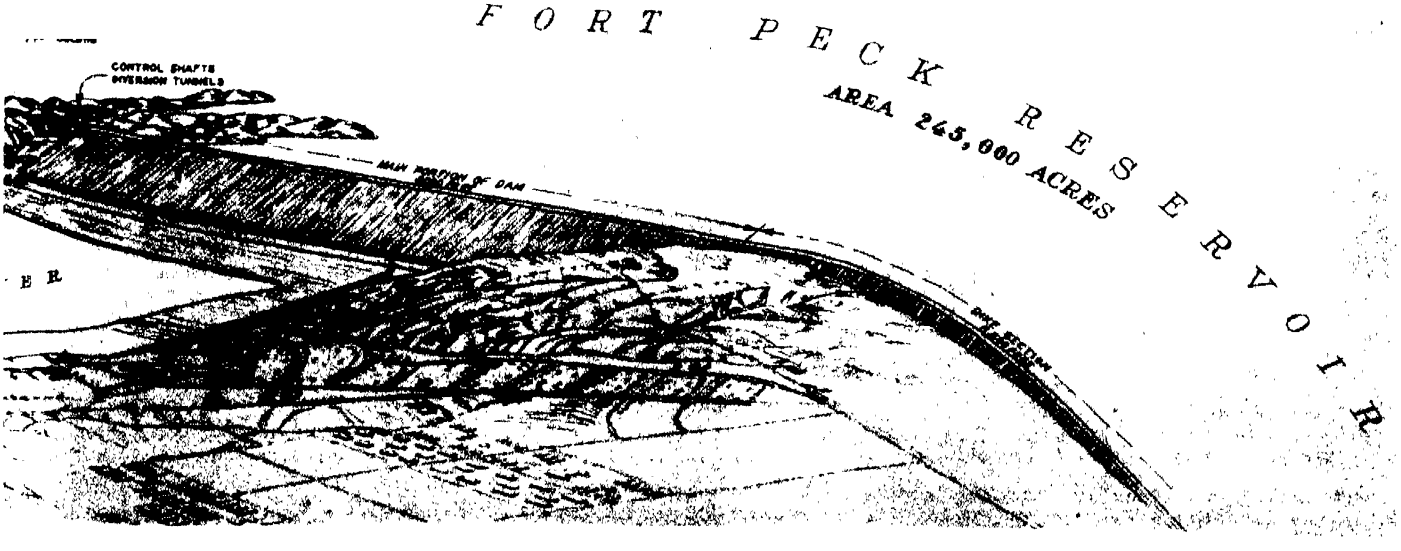
The great majority of modern dams of large size are of masonry construction and commonly built of concrete; but all such dams are usually set on solid rock or else supported by piles that are driven far enough into an underlying formation to provide the necessary stability. The prevailing thickness or depth of the alluvial overburden resting upon the underlying shale made this common procedure impracticable at Fort Peck. Therefore, the Army engineers decided to erect a monster bulwark of earth and to dredge that material directly from the river bed or from the contiguous flood plain. When finished, the Fort Peck Dam will be the largest earth-fill dam in existence. Its magnitude is essential because the alluvium of which it is to be formed must be arranged high enough and strong enough to confine an immense volume of water. The lake so brought into being will extend upstream a distance of 187 miles and have a width where broadest of 16 miles. Thus, the very mixture of sand, gravel, and clay that the river has deposited over a very long period of time will be dredged and pumped into an area surrounded, where necessary, by suitable dikes of gravel to build up gradually a massive impounding barrier directly athwart the normal flow of that very river. In other words, the engineers are utilizing the readiest material to be had in that isolated region to construct the dam that is to help regulate the year-round flow of the Missouri and to improve its navigability and its economic value.

Looking westward toward the trestle-enclosed area. Dump cars used this trestle for placing the dam's gravel toes. In foreground are excavations for the valve shafts

The main body of the Fort Peck Dam is to have a crest length of substantially 9000 feet. From the lowest point of its core wall to the crest that will carry a broad roadway, the dam will have a height of 273 feet, and will be the means of raising the water in the reservoir to a flood level 220 feet above the present river bed. To assure a firm footing for the dam, that structure will have a transverse basal spread of 2875 feet—more than half a mile, and the upstream and downstream faces will slope gradually to the crest which will have a width of 100 feet. The upstream side of the crest will be surmounted by a masonry breakwater which will increase the total height of the dam by 14 feet. The entire upstream slope will be covered with a two-foot blanket of gravel on which will be laid a massive course of ponderous boulders. This covering will protect the upstream slope from the erosive action of storm waves or the scouring attack of heavy floating ice carried on the surface of the lake in winter. The boulders are of glacial origin, and are being gathered from deposits 70 miles away; the 5,000,000 cubic yards of sand and gravel, for concrete and other purposes, are being obtained from immense glacial deposits in the vicinity of Cole, Montana, 80 miles distant by rail from the dam site. Neither transportation of this material nor any other work could be begun at the dam site until the area was made accessible by a branch line 12.2 miles long that taps the main stem of the Great Northern Railway at Wiota, Montana.

Where the dam is rising, the winding river flows from south to north, and the longitudinal axis of the dam is, therefore, along an east-and-west line. At its

Air-view drawing of Fort Peck Dam and reservoir. This drawing, from one by the Corps of Engineers, United States Army, shows long dike sections and the spillway far off to the left side



western end, the dam will be joined by a massive earthen dike that is to extend westward a distance of 11,500 feet. The combined impounding structure will, accordingly, have a length of about 3.9 miles. The final dimensions and form of the dike are undetermined and are awaiting the outcome of large-scale model tests being made near the dam.

The main body of the dam will be tied at each end to a bluff that rises to a height of about 300 feet above the floor of the valley. The bluffs are 7500 feet apart, and are outcroppings of the prehistoric shale that underlies the bed of the river. The formations will provide satisfactory anchorages for the two flanks of the dam; the eastern bluff, because the shale there is sounder, provides better rock through which to drive the four large diversion tunnels that have a combined length of 25,268 feet—the shortest being 5370 feet long and the longest being 7254 feet from end to end. The river will be detoured through the tunnels when the construction of the dam reaches a stage requiring the blocking of the stream. Subsequently, the tunnels will be fitted with immense valves and will then control the water released from the lake to maintain a satisfactory flow in the improved channel between Sioux City and the Mississippi.

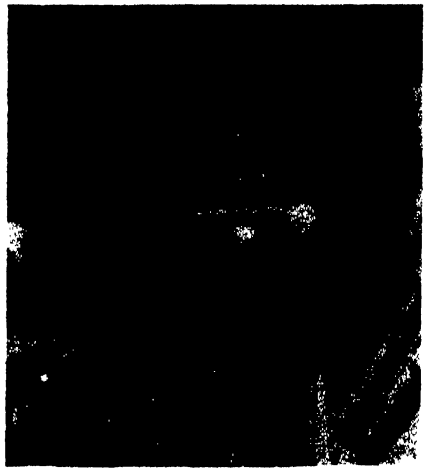
To reach the firm subsoil of the ancient river bed to assure a stable foundation, an area about 2800 feet wide and 8000 feet long had to be cleared of the unstable topsoil to a depth ranging from 3 to 30 feet, removing, all told, about 4,100,000 cubic yards of material. The remaining subsoil, while composed for the most part of fine-grained sand, is interspersed with layers of coarse sand, gravel, and clay.

As the porous sand and gravel might permit water to work under the dam and undermine that structure—especially whenever the level of the reservoir should induce a considerable hydrostatic head—the Army engineers have provided a cut-off wall formed of interlocking steel-sheet piles that have their bottom ends lodged firmly in the shale and their top ends projecting 20-odd feet above the ground. These tops will later be embedded in the basal section of the impervious core that is to act as a backbone for the dam. Some piles have been driven to the great depth of 163 feet; each pile is made up of two sections that are welded together to assure the necessary combined length. The piles have been driven by gantry cranes that have towers approximately 200 feet high.

THE lower section of each pile, about 80 feet long, was sunk its full length with the aid of an ingenious hydraulic spade that excavated a hole into which the pile could be dropped. Each spade was made up of a steel pile 190 feet long that was equipped with tough steel teeth at the lower end that projected beyond multiple jets that operated at a pressure of 200 pounds. The spades greatly simplified and expedited the work of getting the lower sections of the piles for the cut-off wall planted without hammering. When the lower length was sunk, then the upper length of a pile was welded to its companion and the completed pile was driven down and into the shale by a powerful pneumatically operated hammer. From end to end, this exceptionally deep steel diaphragm has a length of 10,146 feet. Where the diaphragm crosses the river, the piles are level with the water bed to leave an unobstructed channel for the dredges, lighters, and other craft employed on the undertaking.

The four diversion tunnels that pierce the bluff at the east end of the dam have a maximum excavated diameter of 32 feet 2 inches; but, when the thick reinforced-concrete linings have been constructed, the internal diameter will be reduced to 26 feet. Up to the close of last year, the contractors had completed the pilot tunnels which will be enlarged to the full dimension just cited; the downstream portal structure, a large part of the upstream portal structure, and the excavation of the control shafts had been completed; and 5000 feet of the main tunnels had been enlarged and lined. The control shafts will contain the great valves that are to regulate the release of water from the reservoir. All work of tunnel driving and shaft sinking has been made extremely difficult because of the tendency of the penetrated shale to crumble rapidly when exposed to dry air. Therefore, it has been necessary to keep the air moist by continuous spraying to minimize crumbling until the rock could be coated with an atomized bituminous mixture to seal the shale surfaces before the concrete lining could be placed.

At the present time, the dam site is bisected by the river, and placing of the earth fill has, therefore, been carried forward in two sections. The plan is to raise these sections to a height of 100 feet, then to shut out the river, and next to construct the intervening section and so bring the entire structure up to a common level. It is believed that the tunnels can be finished so that the river can be diverted into them by the middle of 1937. When cold weather



Placing steel work in one of the tunnels before lining with concrete

called a halt on dredging and pumping, the dam contained 21,742,000 cubic yards of hydraulic fill, independent of the gravel placed in the upstream and the downstream dikes or toes and the sand barriers or dikes erected at the river bank of each section. The dam will contain 100,000,000 cubic yards of earth fill when finished; the body of the structure is now somewhat more than one fifth completed.

To upbuild the Fort Peck Dam, the Army engineers designed and then constructed at a shipyard, called into being nearby, four floating dredges that began operating in the fall of 1934. Each vessel carries two 28-inch pumps driven by 2500-horsepower electric motors. A ro-

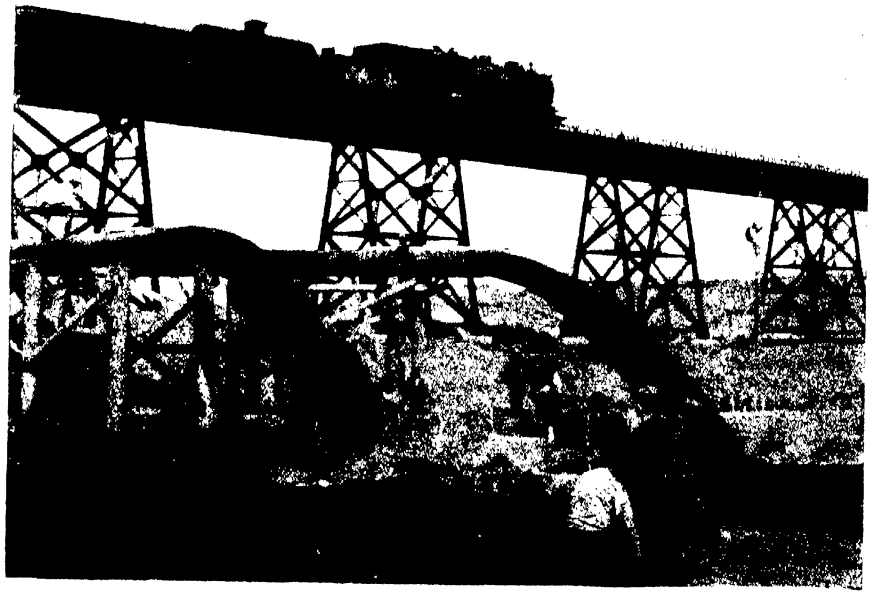
All photographs courtesy Great Northern Railway

The outlet portals of the four control tunnels that will have a diameter of 26 feet when lined with concrete. These tunnels range in length from 5370 to 7254 feet

tary cutter seven feet in diameter digs into the river bed or into the area of any one of the marshy borrow pits, and the excavated material is picked up by the suction pumps and driven through a 20-inch pipe line to a floating relay station or booster plant. That plant has two more pumps that force the muddy mixture along to a land booster plant, and the latter transmits the heavy fluid through a succeeding pipe line to the arranged discharge point within the dam area. Each of the four dredging outfits and their associate boosters is capable of moving the heavy mixture a total distance of 17,000 feet and raising it to a maximum elevation of 240 feet. The four units were expected to maintain a schedule of 3,000,000 cubic yards each working month, but they have exceeded that.

The pipe line, through which the mud and water solution for the core is pumped, rests on pontoons. In background is a suction dredge at work. A floating booster pump plant is in the center

Below are shown outlets of two of the pipe lines discharging the earth-fill —a muddy mixture—into the dam area. The mud settles out; water is drawn off at a distant point

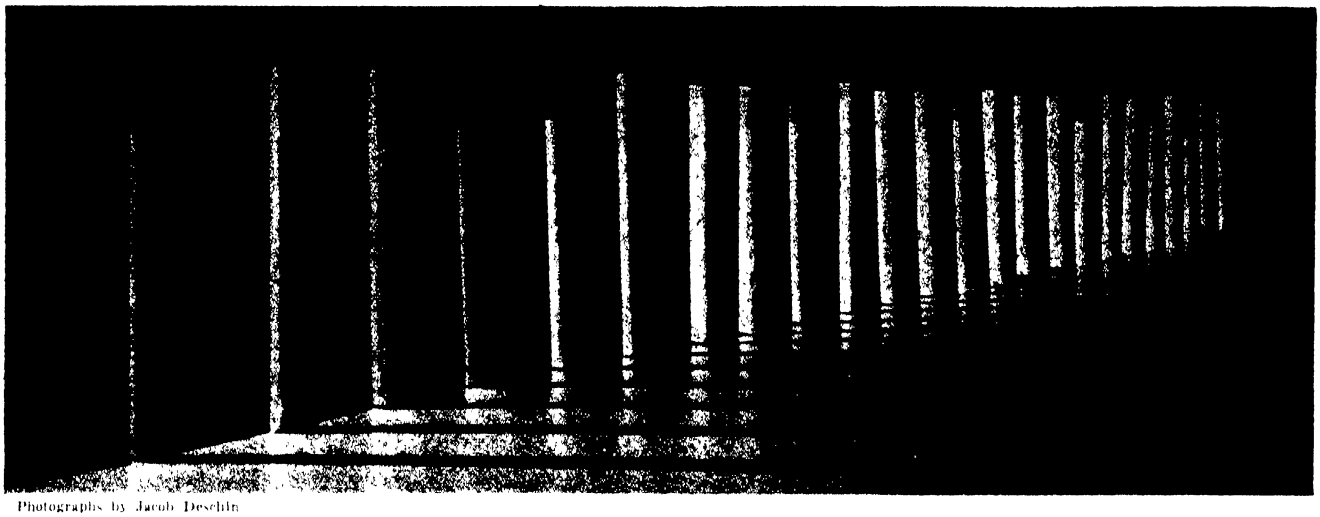


As the muddy mixture leaves each discharge pipe it falls on a timber platform that scatters the flood and robs the stream of any scouring force, and most of the solid matter settles into place. The excess water is drained away through wooden sluiceways that are stepped and staggered so as to lead the escaping water, without destructive turbulence, back to the river. In this manner the earth fill is distributed and progressively compacts itself as it mounts higher and higher and the water drains out of it—the weight of the accumulating mass increasing the pressure and hastening solidification. The central core wall will be composed of fine silt while the enveloping so-called shell will be made up of an earth fill consisting of larger particles. The core-wall will have a base spread or width of 500 feet and its sloping sides will rise sharply to a crest about 60 feet wide. Hundreds of exploratory drillings into borrow pits and the river bed revealed the composition of the alluvial stratum that is supplying the material for the dam, and a careful check is being continuously kept on the exact nature of the mud that is being dredged and pumped into each part of the dam so as to assure uniformity in the shell areas and the proper fineness of the material going into the core-wall body.

Three and a half miles eastward from the dam, nature provided a narrow dry valley or coulee that is being turned into a spillway and a channel to lead excess flood water back into the river at a point about eight miles below the dam. That spillway is to be equipped with 16 gates 40 feet long and 26 feet high; and when those barriers are raised, the spillway will be able to carry off a maximum estimated flood of 254,000 second-feet of water. The spillway will be a unique and very large structure built mainly of reinforced concrete and carefully designed to be enduring in spite of the physical difficulties and the none-too-stable character of the shale lying immediately beneath the excavated channelway.

THE Fort Peck Dam is so diversified in its arrangement and the tasks involved in its construction are so varied that the present article has been limited to presenting only the broad aspects of the subject. Enormous quantities of earth and shale have had to be cleared away with exceptional rapidity, and ways and means have been employed that establish new records of performance. What has been done at Fort Peck has shown the feasibility of still greater construction jobs. In that section of the country the thermometer mounts normally to 110 degrees, Fahrenheit, in the summer, and drops to 40 degrees below zero, Fahrenheit, during the bitter winter season. To house comfortably a working force of more than 6000 persons in the immediate neighborhood of the dam, the Government created the well-ordered township of Fort Peck, a self-contained community of separate dwellings and dormitories, stores, a motion picture theater, community hall, hospital, grade school, fire department, an ample water supply and sewage system, and other essential facilities. In neighboring communities of recent creation are accommodations for those other people that are identified directly or indirectly with the work at the dam. The electric energy used for many purposes in the town and in connection with the project is transmitted from Great Falls, Montana, over a 288-mile power line built especially to serve Fort Peck. The current is transmitted at 154,000 volts. The most modern apparatus has been used to excavate and to carry away many million cubic yards of material in astonishingly short periods, and that has been accomplished by the closest kind of co-ordination between the excavating machinery and the scheduled movements of capacious and high-speed motor trucks.

All in all, the building of the Fort Peck Dam is a truly vast undertaking. Nature has not made that monumental job an easy one, but, even so, the work is being done well and withal expeditiously by the men responsible both for its direction and its execution. The project should command the interest of the general public and the close attention of engineers and constructors the world over.



Photographs by Jacob Deschin

If You Smoke

Was Father Right? . . . Why We Smoke . . . Cigarettes Least Harmful . . . The Newer Moistening Agent . . . Acidity . . . What Answer Gives Science?

By ALBERT G. INGALLS
Associate Editor

"IT prepareth the stomache for meat; it maketh a clear voice; it maketh a sweet breath."

This was probably the first high-voltage tobacco advertisement. Its writer was William Barclay, Doctor of Physicke, and the time was 322 years ago. Dr. Barclay was not selling tobacco. He merely entertained some illusions.

No modern writer of cigarette advertising has attained to higher levels of ballyhoo than this, but a few of them are doing their best. College coaches must smile when they see advertisements that suggest the benefits which their best athletes would obtain from smoking, and a large part of the public doubtless smiles with them. How many smokers would claim that smoking improved their health? Most of us who smoke do so for a single reason, but it is a fairly good one: because we like it. The real harm it does to a few of us, and the small harm it does to the rest of us who smoke, is only a minor charge against our enjoyment—considerably too small a charge, most of us think, to outweigh the pleasure we get out of smoking. If this were not true we would not smoke. The charge against some other habit might be so high that it would outweigh the pleasure. For example, the charge against the murder habit is so heavy, and the harm the hangman would do us is so extensive and permanent, that many of us do not acquire it. It is also dangerous to climb mountains and stepladders, play football, to cross the street, or merely to exist, but the risk is so small that we willingly accept it. With all of these things, as with smoking, the harm or the danger is a matter of degree.

Here are some of the things that *can* happen to you if you smoke: cancer of the tongue, toxic effects on the brain, muscular tremor, jumpiness, irritability, neuralgia, vertigo, insomnia, headache, aphasia, lowered mental efficiency, tobacco amblyopia, deafness, tinnitis, tobacco heart, high blood pressure or low blood pressure, hyperchlorhydria, tobacco dyspepsia, spastic constipation, pharyngeal catarrh, and a round scolding for dropping ashes on the rugs or leaving butts on flower pots. And so it is a wonder that any of us are alive at all. Since the human race has not yet gone to the bow-wows there must be a discrepancy somewhere, for only a member of the Anti-Tobacco League would read such a scare-you-all list perfectly straight-faced. Most of these things don't happen or, if they do happen, they do not all happen at one time; while a single minor difficulty is often a rather companionate thing to have, as in the case of a dog that feels lonesome without at least one flea.

YOUR grandfather—or possibly your father if you are old enough—probably thought cigarettes were sissified. He asserted that a youth who began the cigarette habit would "kinder peter out," if not worse, and he believed it. He called cigarettes "coffin nails," but he made no objection to cigars or a pipe. But every generation has thought the next generation was "kinder petering out." Those who were supposed to peter out grow up and in their turn worry about the next generation.

When you were 21, and grandfather or father perhaps suspected you *might* have tried smoking once or twice, you had already tried it first when you were eight, had smoked cornsilk often till you were 12, and then graduated to Bull Durham, which you as a budding racketeer accepted once a week from your older sister's boy friend, as a *quid pro quo* for not hanging around too close when he made his call on Sunday nights. So, when you had reached a full 21, your grandfather or your dad thrust a *cigar* at you and said, "Here—if you must smoke, get behind one of these and be a real man."

By definition, if smoking injures the race more than it helps, it is immoral in itself—and to the net extent that it injures. But there are really heavily immoral conditions that need attention first—enough to occupy us for the first 1000 years. In the meantime we shall probably smoke.

The editor of this magazine receives occasional letters from persons who seem vigorously opposed to smoking and tobacco advertisements. But, since all of its editors smoke, any apology for the

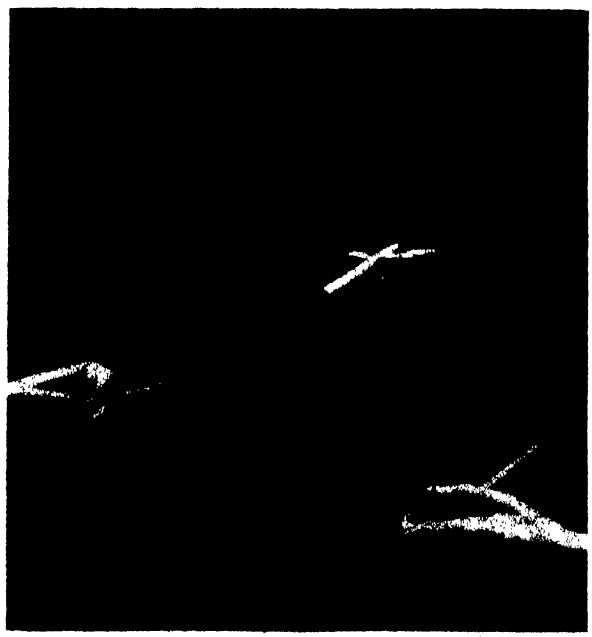
addiction would be hypocritical. Being smokers, and supposedly "scientific"—although scientific people often do the most unscientific things—they have endeavored to find out, largely from literature buried in medical libraries, what scientific angles smoking has, and the following notes present some of the more important findings. It seems odd, considering that the tobacco industry ranks as one of the largest of the world and that there are many millions of tobacco users, how few of the discovered scientific facts about smoking have been made generally available to the public.

What of the effect of smoking on the mind? Professor J. Rosslyn Earp tried to find out whether the best scholars at Antioch College were smokers or non-smokers. Probably the average smoker would concede this point in favor of the non-smokers at the outset. Professor Earp compared the grades of 177 smokers and 176 non-smokers and reported his findings to *The Lancet*, a leading British medical journal. Of the non-smokers, 31.8 percent failed to graduate, while 57.1 percent of the smokers failed. He also cites other investigators. In the Army alpha test (which, however, has lost at least a part of its earlier prestige) S. N. Powers found that high school boys who smoked were given a quotient of 98.6, but those who did not smoke reached 112.5. The Miller and Terman tests gave comparable results. E. L. Clarke found that 18.3 percent of smokers and 68.5 percent of non-smokers at Clark College won honors in scholarship. George L. Meylan of Columbia University found smokers and non-smokers failing in the ratio of 10 to 4. To labor these differences would be useless, for probably few will dispute them. Just what they signify is harder to pin down. In *The Lancet*, Prof. Earp says:

"SCHOLARSHIP demands the *exercise of attention* which cuts off the individual from his fellows. This solitude of mind is incompatible with the gregarious instinct. According to this theory, the tobacco habit has only an incidental connection with low scholarship by being related to the gregarious tendencies of man. The smoker smokes because it is a social habit. He has low scholarship because he is sociable. If some disease yet undiscovered should strike the tobacco crops and sweep that vegetable from the face of the earth, those who now smoke would not, according to this theory, advance in scholarship. They would continue to employ their leisure hours in social intercourse rather than in study.

"*The Habit of Smoking Devitalizes Ambition.*—This is the theory which is expressed by Emerson in the following words: 'The believing we do something when we do nothing is the first illusion of tobacco.' Whether the fumes of burning tobacco are poisonous or not, there is no doubt that the habit once established gives rise to more or less craving for this form of indulgence. It is contended that in satisfying this craving, other less insistent cravings, among them the craving for knowledge and scholastic success, tend to be neglected. The observations that 'heavy smoking' is more closely associated with low scholarship than 'light smoking,' and that as time goes on the smoker's scholarship tends to decline, are not out of harmony with this theory. We should also expect to find the smoker's intelligence unimpaired, as, in fact, we do.

"That some poison or poisons in the smoke acting upon the central nervous system produce a *deterioration of nervous tissue* leading directly to a lower mental output. This is the only theory, as far as I can see, which would explain an independent association of 'inhaling' with low scholarship. The amount of time given to social intercourse by those who inhale surely cannot be greater than that given by those who do not inhale. The much greater absorption of the vaporized products of tobacco is, indeed, the only obvious distinction which delimits the first group from the second. This theory is also supported by the observations of the progressive decline in the scholarship of smokers and by the lower scholarship of the heavier smokers. It is supported also by the nerve injuries known to be associated with excessive use of tobacco—e.g., amblyopia, deafness, tachycardia—and by the nature of the poisons which tobacco is known to contain.



"On the other hand, we have to remember that many men of great intellectual eminence and achievement have been smokers. We note, too, that intelligence as measured by psychological tests is not affected by smoking. Moreover, if a chronic poisoning process of any considerable significance is taking place it is astonishing that the correlation coefficient between scholarship and the length of time of indulgence in tobacco is negligible.

"On the whole," Professor Earp concludes, "it seems likely that more than one, perhaps more than all, of the explanations ventured above are necessary to cover all of the facts," and he later sums it up thus: "That non-smokers excel in scholarship seems to be indisputable. The reason or reasons for their excellence are still very uncertain." In his articles Professor Earp does not moralize.

A QUESTION which may be asked at this point is this: To what extent does success in life (whatever "success" really is—and in turn who can answer that?) depend on scholarship, and to what extent on sociability—on mixing with others, thus acquiring tact, gumption, and, in short, becoming better adjusted to life and obtaining a better chance at success through sociability? For it is not as easy to isolate the ultimate values in life as it is to compile statistics. Who can say, for example, that a man who attained high scholarship, won distinction, and made millions (at the cost of a lot of work), is better off and really has succeeded better, than another who, at 85, looks back on a moderately commonplace life during which he did only fairly well in school, made no millions, and won no special distinctions, but burned two full cords of cigars or cigarettes or a cartload of pipe tobacco, and was serene and happy?

Thus, in final analysis, the whole question of smoking leads us to unanswerable philosophical questions. There is no final or "correct" answer to it, even in the realms of science. Your own answer to the question is, for you, probably the correct one.

Walter L. Mendenhall, M.D., Professor of Pharmacology at the Boston University School of Medicine, has neatly summarized some of the scientific facts surrounding smoking, in a little book entitled "Tobacco." One of the first things he mentions is that, in Holland, children smoke. Thirty percent of the boys smoke before they are nine, 50 percent before they are ten, and about 80 percent before they are eleven. He finds no evidence substantiated by scientific facts to support the claim that

tobacco stunts the growth. What we often hear, regarding the "sturdy Dutch burghers," seems to belie what we should expect as a result of Dutch boys' early smoking. All of this is definitely contrary to a rather sacred tradition. Nevertheless, if it is true, a lot of boys and grown men owe their fathers a return session with the slipper. This is not, however, a recommendation that children take up smoking. That question may well be left to their parents.

Prof. Mendenhall discusses the bodily effects of tobacco under five headings. To the circulatory system it carries an increase of pulse rate—5 to 10 beats per minute—and a slight rise in blood pressure. Ordinarily, this is no disadvantage but it shows up in athletics where there is already heavy stress. To the alimentary tract the excessive use of tobacco causes loss of appetite, seems to favor duodenal ulcers, may possibly cause cancer in the mouth, and commonly causes chronic intestinal catarrh. To the respiratory tract, prolonged, continuous smoking may cause chronic irritation of throat and larynx, also bronchitis and tonsilitis. To the eyes it may cause dimness of vision, derangement of accommodation, and dilated pupils.

The most interesting effects of smoking are those which occur to the central nervous system. Like alcohol, tobacco is often called a "stimulant"—it is said to pep you up—but instead, much like alcohol, it is mainly the opposite: a sedative. Professor Mendenhall points out that it has an effect similar to that of rest, and he calls cigarettes "a package of rest." This is probably the main basis of the smoking habit, although in many cases the "feel" of the cigarette or pipe or cigar in the mouth is the basis of the same habit, on its own account. The source of the "rest" in tobacco is the nicotine in it. Perhaps this accounts for the well-known fact that de-nicotinized tobacco has cut no wider swath than de-alcoholized beer once did; or, to put it as cynically as the anti-tobacco group doubtless would regard it, "When the cussedness is very painstakingly removed from their tobacco the ingrates don't seem to want it. This looks like total depravity." Such a statement would be substantially correct, as nearly every smoker, with a chuckle, would both admit and assert; for life without a little cussedness is pretty tame. Nicotine, then, has a calming effect on the central nervous system, and this is probably the main reason why smokers smoke. But nicotine also has bad effects. Few smokers will deny this.

Prof. Mendenhall points out that the nicotine in tobacco is probably not the element responsible for the throat irritations caused by smoking, but that this is chargeable to the tarry substances in it. Ammonia, a gas, is also derived from a cigarette, and this is an irritant.

Finally, he states a fact which is not always quite frankly stated when the percentages of nicotine in various kinds of tobacco are given. "The nicotine in tobacco has no strict relation," he says, "to the amount of nicotine appearing in the smoke." He cites the following sets of data, for a cigarette smoked in ten minutes by intermittent suction. The first column states the analysis of the smoke drawn through the cigarette, while the second column gives that of the smoke collected from the burning end of the cigarette.

	Mainstream (mouth)	*Sidestream* (end)
Carbon dioxide	21. cu. cm.	336. cu. cm.
Carbon monoxide	3. " "	12. " "
Nicotine	0.2 mg.	9. mg.
Ammonia	0.0 "	3. "
Aldehyde	0.4 "	1.3 "
Furfural	0.0 "	0.1 "
Acid, tenth-normal	0.5 cu. cm.	

There is no question but that many—very many—smokers are inconsiderate of others who do not smoke; in fact, smokers are inconsiderate of one another, since many who love the cigar regard cigarette smoke as obnoxious, and many cigarette smokers dislike the acid smell of cigar smoke; while a potent pipe, such as one of my editorial colleagues possesses, is easily competent to break up a riot or stop a dog fight.

A few years ago Sir Humphrey Rolleston who, by the way, was personal physician to the late King George V, and is Professor of Physic at Cambridge University, in an address given before other physicians and published in *The Lancet* dwelt at some length on the medical aspects of smoking. He, too, pointed out that the important thing to know about tobacco is not its nicotine content but how it is smoked. "The nicotine content of the tobacco and of its smoke," he says, "do not vary directly the way in which the tobacco is smoked and the degree of combustion being the important factors; thus Virginia cigarette tobacco contains (1.4 percent) nearly twice as much nicotine as Manila cigar tobacco, and yet the cigar smoke contains more than double the amount of nicotine in the cigarette smoke (Dixon); the smoke of Virginia cigarette tobacco contains 0.06 percent only of its nicotine content when smoked as a cigarette, but when burnt in a pipe 37 to 53 percent of its nicotine content.

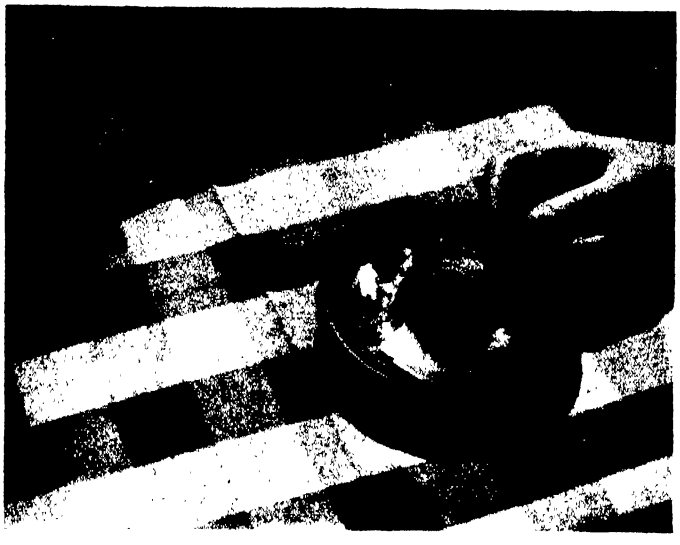
"THE degree of combustion is most complete in cigarettes of all kinds, least in a pipe, and midway in the case of cigars. In pipes, as much as 70 or 80 percent of the nicotine in the tobacco may pass into the smoke; a good deal, however, turns on the length of the mouthpiece; a long pipe is, therefore, better than a short one; thus a clay pipe or a churchwarden allows the nicotine to condense in the stem, to such an extent that very little passes into the smoke. It has been stated that a smoker who re-lights a pipe or cigar absorbs more poison than he would from 10 ordinary smokes (Kionka). According to Dixon the smoke of one cigar contains as much nicotine as 12 to 18 cigarettes.

"The general opinion," Sir Humphrey goes on to state, "is that cigarette smoking is the form likely to give the worst results, then cigars, and lastly, pipes. On the other hand, the order has been reversed. The content of nicotine in cigarette smoke is much less than that in the smoke of pipes, that of cigar smoke being between these two extremes.

"The effects of cigarette smoking appear to be chiefly due to carbon monoxide (Dixon), pyridine, furfural, and ammonia, whereas cigar smoke is powerful mainly on account of its nicotine content. Virginia cigarette smoke contains furfural, while Turkish cigarettes supply very little, and cigars and pipe tobacco none. Furfural, pyridine derivatives, ammonia, and carbon monoxide are distillation products from vegetable material, and are not, like nicotine, in any way special to tobacco, but by their irritating effects on the mucous membrane of the throat and upper air passages may in some way account for the evil reputation of cigarettes."

Chemical analyses, figures, and statistics are interesting but, like all statistics, they must be interpreted in terms of

something else, and often that interpretation runs off the track en route. Since the aim is to ascertain the relative harm done to the body by smoking in its various forms, perhaps the body itself is our safest gage of the extent of that harm. In other words, our feelings in many if not most cases tell us directly, without recourse to any roundabout scientific indications. We know when we have had enough dinner or enough chocolate candy, because Nature tells us so. Likewise most of us doubtless know when we are smoking too much, and some of us then cut down on our smoking. The remainder pay a doctor to repeat back to them, as doctor's orders, what they practically know already, or else they go on until something happens. Certainly attempts to prove by science that, because there is "so many times as much" of this or that in cigarette or cigar or pipe smoke, such forms of smoking are "so many times" worse for us than some other form, as has sometimes been deduced, seem unwarranted. The experience of the individual as well as the integrated experience of millions of smokers, may have more force here than such theory.



SOME research performed by Doctors Irving S. Wright and Dean Moffat of New York, and reported in the *Journal of the American Medical Association*, reveals facts which may interest case-hardened old smokers whom many of us suppose to be wholly immune to such "juvenile" effects as nicotine nausea. (Sherlock Holmes, being a hard-boiled smoker, always saved up all the choice "plugs and dottels" which he had knocked out of his last night's pipes, and enjoyed them as a sort of special matutinal relish.) Under controlled conditions, these doctors caused groups of confirmed smokers to smoke standard brands of cigarettes, and they found that, with too rapid smoking, even "experienced and heavy smokers showed some of the most profound temperature and symptomatic reactions." Some of them broke out in cold sweat, and underwent nausea, vomiting and fainting. What of this? The interpretation put on it by the two physicians is that the subjects did not smoke in the experiments as they naturally smoked elsewhere. They became so impressed with the occasion that they smoked faster and inhaled deeper than they would on average occasions, and this made them sick. This served to bring out the fact that all smokers unconsciously maintain a close balance between the desired and undesired effects of smoking, by varying the rate of smoking *from moment to moment*. But, the two researches state, "These subjects continued to smoke after the desire to do so had become over-satiated." The assertion is then made that "habitual smoking does not result in the development of an immunity to the toxins of cigarette smoke." This is likely to be contrary to many of our beliefs about case-hardened smokers whom we supposed no amount of steady, rapid smoking would possibly feaze. Tolerance to nicotine is never absolute for any one. In tests mentioned by Dixon, non-smokers vomited with one to two milligrams of nicotine taken by mouth. Smokers required eight milligrams, but no matter how hard-boiled as smokers they were, they vomited when they got too much nicotine. "If a cigarette smoker were to puff 10 cigarettes on end he would probably receive about 20 to 30 milligrams of nicotine—enough to produce a profound physiological effect," Dixon states. "The amount of nicotine in pipe and cigar smoking is much higher. In our experiments cigar smoke contains about twice as much nicotine as cigarette smoke."

Doctors Wright and Moffat accuse nicotine, not carbon monoxide or other constituents of tobacco which it has been the style more recently to accuse, as the offending member. They also point out that the amount of nicotine in a given kind of tobacco, cigarette, or cigar is not the vital consideration but "how much is actually absorbed through the mucous membranes and alveolar walls into the blood stream." They cite some examples: Havana tobacco has 1.5 percent nicotine, Maryland tobacco 2 percent, Virginia tobacco 6 percent, Kentucky tobacco 8 percent. But "the amount of nicotine and other products in the inhaled smoke is influenced greatly," they state, "by, first and foremost, the amount of moisture present, and also the tightness of packing, the length of the cigarette and the rate of smoking. The drier the tobacco, the greater the destruction of nicotine. Dixon states that the water content of the tobacco is more harmful to the smoker than the original nicotine content."

As just stated, the drier the tobacco, the greater the destruction of its nicotine when it is smoked. But a bone-dry cigarette is unpalatable, hence all cigarettes contain a hygroscopic agent. The hygroscopic agent which is most commonly used in cigarettes is glycerine. Another which is used is di-ethylene glycol. A dish or bottle of either of these liquids, if left open for a period, would extract water from the air and increase in volume, even on a dry day or in a desert. Which of these two hygroscopic agents is superior for use in cigarettes is a question about which much debate is going on at present. Numerous tests have been made. One, which was described in *The Laryngoscope*, by Dr. Frederick B. Flinn of the Department of Physiology at Columbia University, pointed toward di-ethylene glycol as the better moisture retaining agent, since it was said to cause less irritation of the mucous membrane. Experiments were made on 100 smokers who smoked a daily average of 28 cigarettes containing glycerine, and who had congested pharynx and larynx, coughs and tongue irritation—the familiar symptoms. After three to four weeks on cigarettes containing di-ethylene glycol the throat congestion had disappeared in 62 percent of the cases, and the remainder were improved. Then cigarettes with the same tobacco mixtures but with glycerine instead of di-ethylene glycol were secretly substituted, whereupon 80 percent of the subjects showed a return to the congested condition of the throat within a week, and in many cases the patients refused to go on smoking the cigarettes and the situation had to be explained to them. "The results from clinical evidence show rather definitely," Dr. Flinn states, "that the combustion products of glycerine are more irritating to the throat than the combustion products of di-ethylene glycol. The combustion products of di-ethylene glycol cause only a slight irritation, if any, of the throat." And he adds that there may be some evidence that they may be beneficial where irritation is present.

If these findings—and other investigators have reached similar ones—are true, why is it that most brands of cigarettes still contain glycerine instead

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Some Remarkable Double Stars

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society

IT is more than 100 years since serious interest began to be taken in the observation of double stars. Wilhelm Struve—the first of a notable family which for four successive generations has furnished the world with distinguished astronomers—surveyed the heavens with his nine-inch telescope (a large one for those days), discovering more than 3000 pairs. He completed his work by making accurate measures of the relative position of the components of every pair, and determining their places in the heavens, so that any astronomer could readily set his telescope on any star he wished. His completed memoir, with letterpress in Latin, then the best international language, might have been taken as the last word on the subject. Indeed, there is a tale of an English astronomer of that day who showed sadly to a friend a just-completed telescope, saying: "It has taken me years to get this instrument finished, and meanwhile Struve has reaped the harvest among the double stars, and there is nothing left."

More than 40 years later, an American amateur, who spent nights with the telescope after arduous days as a court stenographer, invested his savings in a six-inch refractor. This was smaller than Struve's, but as perfect in definition as could be made. With this apparently insignificant instrument Burnham discovered hundreds of new pairs—which the earlier observers had missed because of their closeness or the faintness of the companions—and began a career which led him to full-time work with the greater telescopes, and to the discovery of some 1300 new systems.

IN the long interval between these observers, Otto Struve, the second of the line, had found more than 500 pairs, and other astronomers added smaller numbers: but though some 5000 pairs were known when Burnham completed his work, there was none the less much to be done.

Two experienced observers at the Lick—Aitken and Hussey—planned a campaign, in which every star down to the 9th magnitude, in the part of the heavens accessible from the latitude of Mt. Hamilton, should be examined with the great telescope on nights when the air was really steady. This search led to the discovery of more than 3000 additional pairs by Aitken, and of more than 1000 by Hussey, before his too-early death cut short his work.

After this intensive search, by observers of the highest skill and experience, with one of the world's greatest telescopes, and in an exceptionally good climate, one might suppose that the sea of double stars was indeed fished out—except in the southern skies, where successful work is still actively in progress. Yet one of the most remarkable double stars on record has recently been found in this supposedly exhausted region. Its discovery did not come by chance, in the course of a general "drag-net" survey, but as a result of specific and competent planning.

The great majority of double stars are "physical systems"—that is, pairs which are actually close neighbors in space and in slow orbital motion. For a few dozen pairs, the motion is fast enough to complete a revolution since discovery (at most, within a century or so). For perhaps as many more, the observations cover a sufficiently large part of the orbit to permit a fairly good calculation of the rest: but there are thousands of other systems in which the motion is so slow that, even in a century, the angle has changed by but a few degrees.

We could not be sure that the stars of such a pair are really connected, were it not for the fact that the motion of the pair in space is usually much more rapid than the orbital motion of one component around the other. By comparing observations of the positions of the pair relative to other stars in the field, made at intervals of a few decades, it can be determined whether they are moving together, and hence form a physical system, or in different directions and at different rates. In the latter case we have an "optical pair" composed of stars which are at very different distances from the sun, but happen to be nearly in line with one another at the present time. Perhaps a hundred such cases are known—about as many as might be anticipated on the laws of chance.

There are of course thousands of pairs, especially the fainter ones, for which we have not yet enough information about the motion to settle the question.

If we had three good measures of the relative positions of the components of a pair, at intervals of 30 or 40 years (the third to check the others) and corresponding observations of the positions of both, or at least of the bright one, with reference to the background of faint and distant stars in the same field, we could weed out the optical systems, and classify the physical pairs into those that needed re-observation only about once in 100 years, 30 years, and so on.

Something like 2 or 3 percent of the whole—so far as observations go to date—turn out to be moving faster, so that there is hope that the grandchildren of the discoverer may see a good orbit calculated.

A very few move fast enough to complete a revolution during a single observer's working life. Aitken has had the satisfaction of publishing the orbit of a close pair which he had discovered and observed through a whole revolution. More recently Dawson, born in the United States but working in Argentina, has done the same for a pair of period four and one half years, the shortest then known. But these satisfying experiences come only as incidents in the long labor of making and publishing observations which only the astronomers of the next century will be able to utilize to the full.

Binary stars for which we know the orbits are of special importance, for, if the parallax has also been measured, we may find the real distance of the components, and then, by Kepler's Law, the mass. Fortunately, enough such cases are available to show conclusively that the stars are far more alike in mass than in almost any of their characteristics. To be sure, the brighter stars are the more massive: but a difference of a thousand-fold in luminosity (compared with the sun) corresponds to only about a five-fold difference in mass.

IT follows from this that a system of short period must necessarily have its stars close together—roughly at the distance at which a planet revolving around the sun would have the same period. For periods less than five years, the distance should be less than three times the earth's distance from the sun.

Now a pair as close as this could not be seen double, even with the greatest telescopes, unless it were pretty near us. Taking the minimum easily discoverable separation as 0″.15, the parallax would have to be at least 0″.05, and the distance not more than 60 light-years. For still shorter periods, the limit would be closer.

Reasoning of this sort led De Kuiper (of whose discovery of three white dwarf stars we spoke not long ago), to make a special study, with the great Lick telescope and on the finest nights, of those stars which are known to be our near neighbors in space, either by direct measures of parallax or on account of large proper motion. Among the red dwarf stars, which, owing to their faintness, may have been previously passed over, he found several fairly close pairs, for which one may be reasonably sure that the period will be less than 50 years—and one much more spectacular one.

This is a faint star, of magnitude 9″.2, known only by its catalog number -8°4352 in the Bonn Durchmusterung, with a large proper motion, and a very considerable parallax, 0″.148 ± 0″.004, which means that it is four to one that the calculated distance, 22 light-years, is not more than one light-year in error. In July, 1934, Kuiper found this to be a close and almost equal pair, with a separation of 0″.20. Since that date the stars have been observed in revolution at a substantially uniform rate of 18° per *month*. This indicates that the real orbit is practically circular, and that we see it almost in plan, very little foreshortened by inclination of its plane. The period is 1.66 years—less than half the shortest previously found for a telescopic double, and the mean distance, 0″.185, corresponding to a true distance of 1.25 astronomical units—intermediate between those of the earth and mars. From these values, the combined mass of the two stars comes out 0.7 times that of the sun. Being very nearly equal in brightness, they are presumably equal in mass, each having 35 percent of the sun's mass, and 1/250 of the sun's brightness. The diameters cannot be accurately estimated but are probably something like one third that of the sun, which would make the density of the order of ten times the sun's.

These are remarkable values, but not without precedent, for three other stars are known whose masses are 23, 20, and 16 percent of the sun's, and luminosities 1/700, 1/1700, and 1/3000 of the sun's light. All these stars, including the new discovery, are red dwarfs, of spectral class M, and all agree well with the known relation between mass and luminosity.

Stars of still smaller mass may exist, and even be very numerous, without our having much chance to detect them.

A STAR of one tenth the sun's mass would shine so feebly, and be so red, that it would not show, even on long exposure photographs with powerful instruments, unless its distance was only a very few light-years. Smaller bodies would be effectively dark.

One, at least, appears nevertheless to have been identified. There is a well known binary pair Xi Ursae Majoris—one of Stuve's original discoveries—which has been abundantly observed for the last century, and is well toward the completion of its second revolution, the period being 59.86 years. From measures of parallax it appears that the system is 26 light-years from us, while the distance separating the components averages 20 astronomical units, ranging from 12 to 28, on account of the eccentricity of the orbit—that is, from a little more than Saturn's distance to a little less than Neptune's. A simple calculation then shows that the combined mass of the system is 2.3 times the sun's. The positions of the stars in the heavens have been observed separately and it has thus been found that the fainter star has 77 percent the mass of the brighter, making their masses 1.28 and 0.99 times the sun's.

So far, all is commonplace: but both components, when observed spectroscopically, show, beside the slow changes due to motion with the 60-year period, much more rapid oscillations, proving that each of them is attended by a companion too faint to be directly visible. For the brighter component, the revolution of the companion takes place in 1.83 years. Shortly after this fact had been discovered spectroscopically at the Lick Observatory, Hertzsprung, who was engaged, with great success, in developing methods for accurate photographic observations of double stars, found that his observations of this pair, unlike others, did not follow the smooth ellipse corresponding to the 60-year period, but showed a superposed oscillation, with a period of 1.8 years. It is the center of gravity of the bright star and its companion which follows the exact ellipse, and, by careful study of the measures, it was found that the average distance of the bright star from this point was 0.4 times the earth's from the sun, and that the orbit was turned almost edgewise toward us, being inclined 84° to the apparent "plane of the sky." The orbit of the main pair is inclined 57°, and the two orbits are so placed that their mutual inclination is 28°.

Now the distance separating the bright star from its invisible companion can be calculated from Kepler's Laws, and comes out 1.6 astronomical units. Hence the invisible companion is three times as far from the center as the bright star, and only one third as massive. We know the combined mass, and so can conclude that the principal star has 96 percent of the sun's mass (which is reasonable since it is of nearly the sun's brightness), while the faint component has but 32 percent the mass of the sun. Such a body would still be a *star*, giving out about 1/250 of the sun's light, and hotter all over its surface than an electric furnace: but no existing or projected telescope would enable us to see it so close to its bright neighbor.

The fainter member of the wide pair is also a spectroscopic binary. Berman, at the Lick, found that the period was only 3.98 days, and the orbit very small. The whole change in distance from us, as the visible star sweeps 'round this orbit, is but 350,000 miles. The real diameter of the orbit may be more, since it is possible that its plane is turned almost flatwise toward us. So we assume that its inclination is the same as that of the wide pair. We find that the star is 205,000 miles from the center. But by Kepler's Laws, as before, we can show that the companion must be 4,500,000 miles from its primary. It follows then that the companion is only 1/21 as massive as the others, so that the masses are 0.945 and 0.045 times the sun's. The larger mass is again a normal star, but the smaller one is without parallel in our observational experience, with little more than a quarter of the smallest previously known stellar mass.

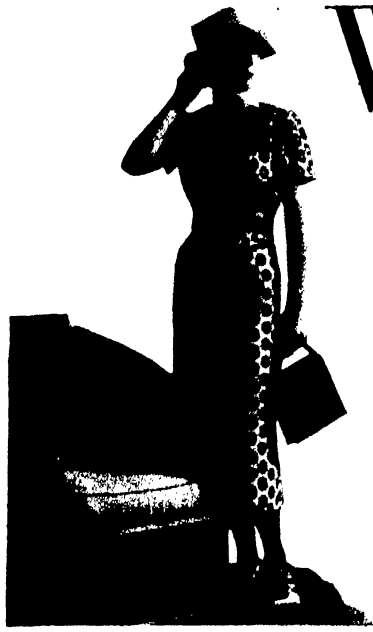
SINCE the relation between the mass and the heat-radiation of a star is founded on good theoretical principles, we are fairly safe in estimating that such a body should give out about a millionth part as much heat as the sun. Its diameter is not so easy to estimate, but if we guess at a tenth of the sun's, we are probably not far astray. This would make the radiation per square mile 1/10,000 as great as for the sun, which demands a surface temperature 1/10 the sun's, or about 600° absolute—below a red heat, and thus the body would be dark, though not cold.

When stretched so far, however, the theory breaks down, for it assumes that the body is a purely gaseous mass. At any such temperature, there would presumably be a solid surface.

It is rather hard to decide whether such a body should be called a very small star or a very big planet. It is so small, and must be so faint, compared with its primary, that it seems planetary. On the other hand, its mass is 50 times as great as Jupiter's, and it is very probable that it is radiating enough heat on its own account to keep its surface hot even if not shining visibly.

There may be any number of such bodies in space. It is only by a combination of favorable accidents that we obtain evidence of this one.

It is fair to remark that the smallness of this companion is not fully proved. It *may* be that the four-day orbit is inclined at a low angle—in which case the division of mass between the two bodies is less unequal. But, since the two known orbits in the system are highly inclined, this is highly improbable—in the writer's judgment, at least.—*Princeton, April 5, 1936.*



WHY FADED FABRICS?

Dye Fallacies . . . Few Cents Determine Fast or Fugitive Dye . . . Dyeing Economics . . . America Makes Fast Dyes . . . Public Must Demand Them

By DR. JOHN H. SACHS

THE author of the accompanying article is one of the foremost authorities on dyestuffs in this country, and has been prominently identified with the dyestuffs industry since its inception on its present basis in America about 19 years ago. He is now an executive advisor on fine dyes in the main office of E. I. duPont de Nemours & Company.—*Editor.*

ONE of the biggest personal nuisances in America today is that of faded fabrics. The economic waste due to this nuisance is enormous, certainly amounting to as much as 50,000,000 dollars annually. Everybody can recall instances in which useful articles of apparel or decoration have been discarded simply because their original color has faded to such an extent that good taste is offended by the result.

Today, man is more color conscious than ever before. He demands that his clothing, from cravat to hosiery, be colored. The pictures in his home are apt to be splashed with bright, often brilliant hues. His car may vary in color from a dark blue to a bright green. He is guided in his choice of food and drink by the natural or artificial color of the articles offered him. One might almost say that nothing else so influences his choice of one article as against another. Yet, too often the color of the material he has chosen rapidly fades; the very property upon which his purchase was based has been destroyed.

Perhaps we should have said that woman today is more color conscious than ever before. It is to her, the American housewife, that the nuisance is most apparent. She deplores it, complains about it—rarely to the right people—and the husband pays the bill for the new frock, the new coat, or the drapery which is purchased to replace the discarded article—dyed with "fugitive" colors.

"Will it fade?" is one of the commonest inquiries raised by women in retail buying. More often than not the seller evades the question, or says bluntly that the color cannot be guaranteed. In this day of scientific advancement on all fronts, and especially with the American chemist leading the world in accomplishment, it is only natural that women should begin to wonder why something is not done about this fading color nuisance.

The chemist's answer is that something has been done. As far as he is concerned there is no reason whatever why every fabric, regardless of its quality or price, should not be dyed in colors that will last fully as long as the fabric does itself under any reasonable service to which it is put. The nuisance and economic waste of fading fabrics—in draperies exposed to the sun, in gowns and wash dresses, in men's apparel, throughout the whole range of fabric uses, in fact—are entirely unnecessary.

WHY, then, the nuisance and how can it be stopped? Why the huge waste? Why faded fabrics at all? Here again the answers are plain. However, in order to understand them it is necessary, first, for one to know something of the history and nature of the materials in use today for the coloring of fabrics, that is, the dyestuffs, or more specifically the coal-tar dyestuffs. This knowledge is essential to intelligent action.

Prior to 1856, all dyes were of animal or vegetable origin, obtained from the juices of berries, from roots, plants, the sap of trees, or, in the case of cochineal, simply by grinding the dead and dried cochineal bug. Then a young English chemist, William H. Perkin, accidentally discovered the first coal-tar dyestuff. He was trying to find a laboratory method for making quinine. In one experiment he sought to determine what would occur by the oxidation of aniline. The result was a black tarry substance which dissolved in alcohol to a beautiful reddish violet solution—mauve. This was the beginning of the coal-tar dyestuffs industry.

Coal-tar is a common by-product of the manufacture of coke. It is a heavy, black, viscous liquid with about the consistency of molasses. Its importance to the chemist came with the discovery that many of the products of nature when broken down are nothing but derivatives of three or four of its most common constituents: benzene, toluene, naphthalene, and anthracene. The discovery was like tearing down a house to find that it was built of bricks, mortar, wood, and nails, but with an important exception. There are many kinds of bricks, mortars, woods, and nails, whereas benzene, toluene, naphthalene, and anthracene are the same the world over. Regardless of where they are produced, whether in England, Germany, America, Japan, or in the wilds of Borneo, they are exactly and unvaryingly one thing. Add a molecule or take one away and they become something else entirely.

Very well then, the chemist argued, if nature combines the elements into compounds that can be broken down into the same products that are contained in coal tar, why not begin with coal tar and reverse the process wherever it is commercially feasible to do so? This is exactly what English and German chemists did. Starting with anthracene they produced alizarine, the valuable substance in madder, a plant dye. Not content to stop there, new dyes unknown in nature were soon produced from alizarine, while dyestuffs more valuable than alizarine were made from anthracene.

The early nineties saw the first successful manufacture of indigo from the coal-tar derivative benzene. There followed a procession of other valuable

dyes of every conceivable shade and brilliance, all obtained from a few substances found in the black, sticky by-product. It was learned that by combining these substances with one another, or with their derivatives, or with other common chemicals, it was possible to produce literally thousands of colors. Most of these colors are of no use commercially, but on one point they have a common characteristic that is as certain as night following day; that is, wherever applied, or by whomever applied, the same methods bring the same results. Each color compound is absolutely definite.

This is a vital fact for American women to remember in coming to an understanding of why one dress fades and another does not. The modern coal-tar dyestuffs are definite chemical compounds, usually of very high purity. Two cooks using the same materials, following exactly the same recipe in mixing these materials and baking two cakes under like conditions of temperature and time will produce identical articles. In just the same way will two chemists, using the same materials and recipe, arrive at identical dyestuffs. Thus, it follows that synthetic indigo made in America is similar in every respect to indigo made in England, Germany, or Japan.

The same may be said of any commercially important dyestuffs. No matter where made, it behaves similarly in its method of application to the fabric. It imparts the same shade and depth of color. If it be a "fast" color made in Germany, then it will be "fast" also if made by the same process in America. On the other hand, if it be a "fugitive" color made in America, it will be a "fugitive" color if made anywhere else —in England, Japan, or Germany.

LET us assume that there are a thousand dyes of commercial importance. This means that a thousand definite chemical compounds are being manufactured in the world today and used as dyestuffs; the important fact to understand here is that each country having a dyestuffs industry manufactures, for the most part, the same compounds as does any other country. Indigo is being produced synthetically today in at least seven countries, alizarine in at least six countries, while some of the less important colors—specialties—might be manufactured only in one.

If all this be true, why, then, the fault of faded fabrics? Is it due to the inferiority of American-made dyestuffs? Or is it because the American chemist is not so skilled as his English or German brother? Is he unable to make the more complicated compounds, which, as a rule, are the better dyestuffs?

The answer to all these questions is an emphatic "No!"

There are many coal-tar dyestuffs with which any fabric can be dyed to any particular shade. Some of these dyestuffs may be very cheap in comparison with others. Therefore, any desired shade can be obtained on any fabric either with a cheap and probably fugitive color or with an expensive and probably fast color, it being almost generally true that the fast dyestuffs are the more complicated structurally and henceforth the more expensive. Why, then, are cheap and fugitive colors manufactured?

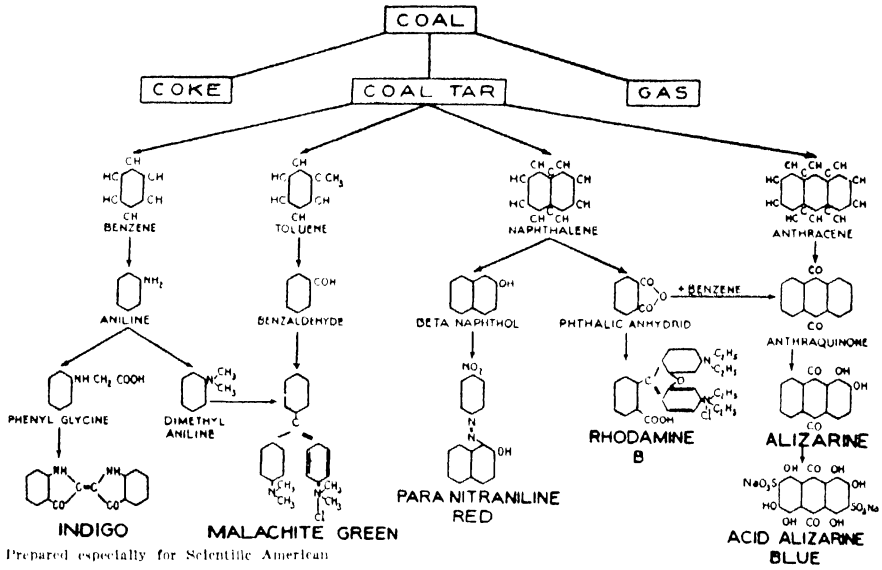
FOR many purposes fast colors are not necessary. During the Christmas season reds and greens predominate in wrapping paper, ribbons, and decorations. The wrappings and ribbons are soon discarded and destroyed. Furthermore, many colored fabrics are never exposed to sunlight; hence the colors need not be sun-fast. In many cases it would be sheer waste to employ expensive dyestuffs for materials which, having served their purpose, are soon deliberately destroyed. But herein lies the answer to the question of faded fabrics. *Cheap colors are available. In too many cases they are used for a purpose for which they are entirely unsuited. This is the genesis of the nuisance and a just cause for complaint.*

In the early years of the World War, the American textile industry was seriously handicapped by the lack of dyestuffs and other chemicals necessary to the industry, which up to this time had been readily procured from Germany. In desperation, some of the firms engaged in this business began to manufacture dyestuffs and other chemicals they required. Obviously, the first colors produced were the simpler ones, which, as a rule, are the fugitive ones. And who can forget the result? For a period of about five years no dependence could be placed upon the color in any dyed or printed fabric. It was during this time that the American public was educated to believe that Germany alone possessed the chemical skill to manufacture fast colors. And, in fact, this was the case at that time.

But the later years of the war saw the birth of a really great American dyestuffs industry. And the decade immediately following the war witnessed the growth of this lusty youngster into a full-grown adult. In no other field of the chemical industry was growth as remarkable as in the manufacture of dyestuffs. Practically all colors on which the Germans had enjoyed a monopoly until 1914 were scrutinized by the American chemist. He studied their properties and the technique of applying them to fabrics; most important of all, he developed processes for their manufacture, to get the same definite chemical compounds, mind you, that hitherto had been manufactured only in Germany. As a result, there are today in America a number of well-established, reputable firms engaged in the manufacture of reliable dyestuffs.

The answer to the problem of faded fabrics comes with an understanding of the cost of dyestuffs in relation to the value of the fabrics on which they are applied; in other words, the value of the dyestuff in a $50 gown or a $50 suit of clothes. In the gown the color may be worth from five to 30 cents, in the suit from 15 to 50 cents. But there are many gowns, many suits, and many yards of merchandise sold from the piece each year. When the cost of dyestuffs in a single gown, suit, or yard of cloth is multiplied by the number of gowns, suits, or yards of cloth, the aggregate is an item that must be given consideration. Let us develop this thought.

Exemplifying the spirit of the dyestuffs industry. The deman keeps this plant working 24 hours a day, seven days a wee



Prepared especially for Scientific American

At least 30,000 dyes have been made from coal-tar, of which about 1000 are used commercially. In this family tree of six common dyes, we see how they are derived chemically from the four important raw materials contained in coal tar

Suppose a housewife desires to purchase 20 yards of an ordinary cretonne ranging in price from 20 cents to one dollar per yard. She visits a department store and chooses a pattern that meets her fancy. She makes a choice of a certain combination of colors which particularly pleases her. When she inquires about the fastness, the salesman informs her that he believes the material to be dyed with fast colors. The housewife does not consider that the value of the dyestuff in the fabric she buys is indeed a very small part of the price she pays for it. It can be safely said that the value of the dyestuffs in her 20 yards of cloth varies from 10 to 80 cents; that is, from one half cent to four cents per yard. She does not realize further that the dyer printed perhaps 100,000 yards of the material, or that he charged four to 12 cents per yard for his work, this price including materials, labor, overhead, and, of course, his profit. The dyestuffs alone for this amount of cretonne may have cost, therefore, anything from 500 to 4000 dollars.

TAKE, for another example, a cheaper fabric than cretonne—say, percale. This can be dyed or printed for three cents to six cents per yard, the cost of the dyestuff alone varying from one half cent to two and one half cents per yard. Percale is dyed and printed by the millions of yards and a single pattern of 100,000 yards is not unusual. Simple arithmetic applied here shows that the dyestuffs for this amount of material may be worth from 500 to 2500 dollars.

The same facts may be presented in another manner. Let us consider for any particular year the value of the important textile fabrics produced in America in relation to the value of the dyestuffs sold here. For the year 1933 the factory value of all cotton goods amounted to 874,581,000 dollars; the value of all silk and rayon goods, 244,261,000 dollars; and the value of all woolen and worsted goods, 442,399,000 dollars. Assuming that 50 percent of all cotton goods and 100 percent of all other classes of fabrics were dyed or printed, we have a factory value of 1,123,950,500 dollars for all dyed or printed fabrics. Now the sales value of all dyestuffs consumed in America in 1933 was 50,500,000 dollars. It is estimated that 75 percent of the total dyestuffs consumed was applied to textile fabrics, the remainder being employed in the leather, paper, and other industries. Therefore, the value of the dyestuffs applied to the fabrics becomes 37,875,000 dollars. This is but 3.37 percent of the value of all dyed or printed textile fabrics. If the assumption is made that there was an increase of 50 percent from the factory-value to the consumer-price of all dyed and printed fabrics, the relative value of dyestuff becomes 2.25 percent.

The outlay for dyestuffs and other chemicals necessary to dyeing or printing is a considerable item to the dyer, printer, or jobber, the latter the so-called "converter" of the textile business. But in relation to the value of the material he produces, this outlay is almost insignificant. Of course, the dyer, printer, or jobber is entitled to a fair profit in the conduct of his business. But competition is keen in the textile industry; the printing machines must be kept turning and the dyehouse must operate. The difference between the cost of fast color or fugitive color for the 100,000 yards of material may be the difference between an idle or busy factory. The result is a low bid, based on fugitive color, for the dyeing and finishing job—and the contract for the work is obtained.

The goods look nice. They are passed along to the "converter," the garment-maker, and finally to the consumer. Twenty thousand garments, sold for perhaps 10 dollars each, means 200,000 dollars' worth of second-rate merchandise. This is the result of a saving of perhaps 2000 dollars in the cost of the dyestuffs used. Here is the economic waste.

Recently my wife purchased a certain amount of medium-priced cretonne for a chair cover. In due time the cover was made and placed on a chair which stood before a window with a southern exposure. In less than six months the color, which was originally a clear blue, had faded into a dirty grey. The color on the back of the chair, shielded from the sun, survived. The value of the covering, at least from an esthetic point of view, was gone, and it had to be removed from the chair.

At my insistence my wife returned the covering to the store from which she had purchased the material. She was told that since the advent of American dyestuffs, and because of the difficulty of procuring dyestuffs of German manufacture, it was no longer possible to guarantee fabrics against fading. At another time she might have been told that a medium-priced cretonne did not warrant the use of expensive, and therefore fast, dyestuffs.

Responses such as these to customers' complaints are tommyrot. The salesman does not know the facts. He does not know that the value of the dyestuffs used in the merchandise he sells is a very small part of the cost. And being ignorant of this, he does not realize that the use of a cheap and fugitive color for the dyeing of any fabric which is expected to endure for a reasonable season is an economic waste. He does not know that America today possesses a really great dyestuffs industry. He simply is quoting an "alibi" which has been passed along by the manager of his store or perhaps by the wholesale house from which the goods were originally bought.

IF any fault is to be found with the quality of dyed fabrics being currently supplied to the American public, the fault lies entirely with an apathetic public. Better dyestuffs are available today than ever before. When the public is educated to dispute intelligently the arguments of the misinformed sales people, when they are insistent upon fast dye fabrics, then such fabrics will be available at only a trifling increase in cost. Fast colors are available for every reasonable purpose and, in using them, the printer and dyer can still make a fair profit. There is no reason whatever why the buyer should not demand a guarantee of fastness in the color of the fabrics which he or she purchases. The guarantee will come when the demand is general.

FARM TO FACTORY

Chemistry Points the Way . . . Soy Beans . . . Tung Oil . . . Starch . . . Wood Pulp . . . Cotton . . . Rayon

By L. F. LIVINGSTON
President, American Society of Agricultural Engineers

YEARS of scientific research are behind the idea of the industrial use of farm crops as raw materials. World changes in agriculture are tending to make nations more and more self-sustaining, which means that we must broaden our markets at home. One way to do this is by cultivating on American soil those agricultural raw materials we now import. The other way is by finding new uses for our crops in our manufacturing industries. We are following both of these methods of development.

Soy beans furnish the almost perfect example. Introduced in this country over a century ago from China, they were first grown in the South. Acreage was limited, however, and the beans were fed mainly to hogs, regardless of the fact that soy-bean oil was being imported from China for use in the paint industry. Then research tackled the problem and a wholly different story may be told today.

In 1935, almost 5,500,000 acres in 27 states were planted to soy beans alone. This was an increase of one third over 1934. Almost 21,000,000 pounds of American-produced soy-bean oil was used by industry. About half of this went into the making of paint and varnish. The balance went into soaps, linoleum and oilcloth, printing inks, edible compounds, and various other industrial products including automobiles. Gear shift knobs, engine distributor covers, ornamental door handles and other parts of automobiles are now being made out of soy-bean meal. Chemists have found more than 300 possible uses for it.

American factories buy nine tenths of all the tung oil China produces, although American-refined tung oil is superior. Southern farmers aiming at this market now have 250,000 acres in tung trees—it will require one million acres or more to fill the national demand. The American textile industry's annual imports of starch mount to hundreds of millions of pounds, and we are doing something about that too. Only recently at Hattiesburg, Mississippi, it was proved that a better starch is yielded by Southern sweet potatoes at a return of 40 dollars per acre to the farmer for the starch alone.

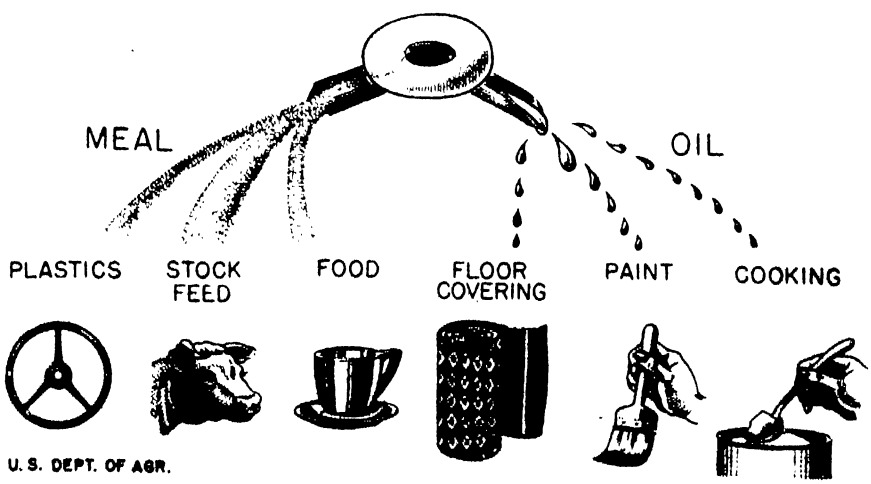
The Farm Chemurgic Council estimates that 50,000,000 acres may be planted to industrial-use crops within the next ten years "if man sets himself to the task." The Council estimates 8,000,000 new acres to provide wood-pulp for paper and paper stock, a forecast that is based on the success of the experiments by Dr. Charles H. Herty with fast-growing southern pines. A paper plant to utilize southern pulpwood is now being built in Georgia at a cost of 4,000,000 dollars, which is concrete evidence of what industry thinks of Doctor Herty's proposition. It is estimated that the use of cotton as a reinforcing material in road construction will consume the output of 3,000,000 acres. Displacement of flaxseed and linseed now imported would add 3,500,000 acres to the American farmers' income-producing plant. And so it goes. The movement is yet in its infancy.

THE South abounds in unexplored possibilities for new crops. In southern Florida they have found that coffee and cacao may be grown if sheltered by larger trees. Rubber from American-grown plants is still a possibility. Artificial temperature control, to protect plants such as the tung tree from winter frosts, is gradually being developed to a practical stage, and what vistas that will open to southern growers only the future can tell.

In 1920, two thirds of the casein used by American industries was imported. By 1934, all but 4 percent of the needs for this dairy by-product were being supplied by home producers, who, with chemical and engineering aid, found it possible to compete with the dairymen of Argentina and elsewhere.

Through chemical conversion into cellulose, the uses of cotton have become literally hundreds. Cotton seeds, once a waste, now have a value of over 200,000,000 dollars in a cotton crop of 1,500,000,000 dollars. Cotton-seed oil, hulls, linters, meal, and cake, all have become valuable materials. Coated fabrics such as "Fabrikoid" consume cotton by the millions of pounds. Cotton enters into the manufacture of cements for leather, textiles, and paper; into water-proofing compositions, smokeless powder, gun cotton, blasting gelatin, coal mine explosives, toilet articles, electric insulators, motion-picture film, golf balls, and women's fingernail polish. The list is almost endless. Rayon is perhaps the outstanding example of chemically-wrought change in a raw material. This first man-made textile fiber, while it might be said to compete with cotton, at the same time really is cotton metamorphisized. And as rayon it has taken its place in fields where cotton as such never has entered. In the aggregate, it is said that the chemist has added 10 dollars per bale to the normal-time value of the cotton crop, and there is as yet no reason to believe that all the possibilities in cotton have been exhausted by research.

THE MANY-SIDED SOYBEAN



U. S. DEPT. OF AGR.

These and other uses of the soy bean are described in the text

THE TWELVE-

Figure 1: **Pedersen. California**

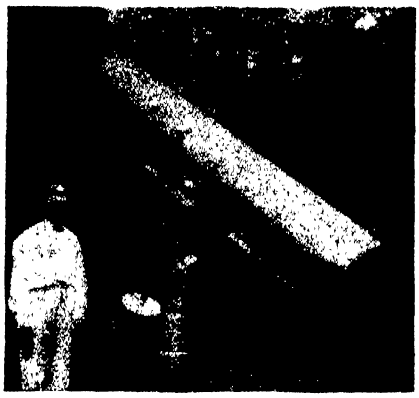


Figure 2: **Haskell. Missouri**

Figure 3: **Schmigdall. Illinois**

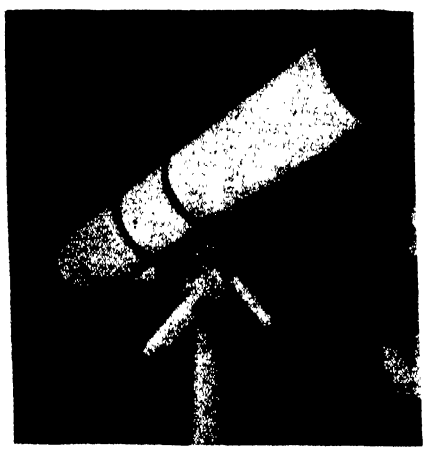


Figure 4: **Lester. California**

A LITTLE more than a decade ago this magazine published an article telling how a group of amateur astronomers in Springfield, Vermont, made their own astronomical telescopes. The response to that article suggested the publication of a book of instructions for making telescopes, since no book was available. A book was prepared and given the title of "Amateur Telescope Making." That book first appeared just ten years ago this merry month of May, and there was then a question whether the edition of 3400 copies would be completely disposed of even within the lifetime of those who prepared it. Instead, the edition lasted two years and it started a new hobby rolling in the U.S.A. Since that time it is estimated that more than 10,000 telescopes have been made by American amateurs.

Ten years ago the receipt of an actual photograph of a telescope made by an amateur was a rare event in the editorial offices, but today scores of them, received from readers all over the nation and all over the world, lie in a toppling pile on the corner of one editor's desk. Most of them depict instruments of ten-, eight-, or six-inch diameter—the latter is the usual beginner's size—but 12 of them happen to be of 12-inch instruments, all of the reflecting type, and these have therefore been sorted out for feature presentation. They suggest how far the telescope making hobby has gone since May 1926, when the attempted amateur construction of so large a telescope would have indicated either outstanding skill or outstanding hardihood. "The Twelve-Inch Club" has no headquarters, no officers, no dues and, in fact, no corporate existence, other than on these two pages. Its 12 members live in seven different states, from Massachusetts to California, and have never seen one another. They meet for the first time on these pages.

MOUNTED on a wooden trunk with casters, so that it may be wheeled out of doors, is the telescope shown in Figure 1, made by J. Arthur Pedersen, 2390 Monterey Road, San Marino, California. The tube is skeletonized, leaving the 12-inch concave mirror clearly visible in the photograph. Instruments of this size will magnify from 100 to 500 diameters, depending on the state of the atmosphere at the time they are used. The changeover from one power to another is made in five seconds, merely by substituting one small eyepiece for another.

Figure 2 shows a telescope made by John E. Haskell, 729 North Main Street, Springfield, Missouri. It has a 12½-inch mirror of Pyrex coated with evaporated aluminum, and, with a 700-pound car wheel which forms the base on which it stands, it weighs 1250 pounds. The eight-foot tube is made of 16-gage sheet iron and the polar axis of 2 11/16-inch steel. All the material except the glass was purchased from the junk yard, and the total cost fell less than 100 dollars. "Mars is fine and Jupiter's belt and his fifth moon are easily seen," the maker states.

Figure 3 is a photograph of an instrument built by C. H. Schmigdall, a maker of boring and milling machines, 307 Cass St., Peoria, Illinois. It is shown mounted merely temporarily on four legs, preliminary to remounting in an observatory

Figure 5: **Tarbell. Missouri**

Figure 6: **Dietz. California**

INCH CLUB

dome of 14-foot diameter. It took two years to build this telescope, including, of course, making its paraboloidal mirror.

Figure 4 was sent by the "Amateur Astronomers of Long Beach," California. This "twelve-inch" is really a 12½-inch with a Pyrex mirror, a tube 15 inches in diameter and axes made of Ford housing assemblies. A drive, to keep the telescope in slow motion in order to offset the earth's rotation, is made of an automobile pump through which water escapes in an adjustable fine stream. William Edward Lester, 5327 Linden Ave., Long Beach, was the maker of this telescope.

FIGURE 5: E. D. Tarbell, 2235 East 67 Terrace, Kansas City, Missouri, compounded his telescope uniquely: the secondary mirror (which is a flat) reflects the beam of light at an angle, as in the Herschelian type. But the same mirror, when folded back out of the way, uncovers a conventional Cassegrainian convex, working with a diagonal and "side entrance" eyepiece. Mr. Tarbell also used Ford housing assemblies but reports them as being too light.

Figure 6 shows a very steady type of mounting a rotatable wooden rectangle, parallel to the earth's axis, with the tube swung on pivots between its sides -- as in the next figure. Top and bottom of the tube are solid, the remainder being larger and open. Ralph W. Dietz, 2187 W. 25 St., Los Angeles, California, is the maker. "I have used a magnifying power of 600 diameters with it," he states.

Figure 7: Edward Katyll, 3416 N. Keating Ave., Chicago, Illinois, was the maker. The solid double yoke is of steel four Ford chassis irons fastened to a 12- by 30-inch channel. There is an electric drive. Weight of moving tube, with 12½-inch Pyrex mirror, 200 pounds. A very rigid mounting. Total cost 25 dollars.

Figure 8: Clarence T. Jones, an architect, 210 Glenwood Drive, Chattanooga, Tennessee, has a whole battery of telescopes of which the one shown, with semi-skeleton tube like the one in Figure 6, is the largest. It has an electric drive, fine setting circles and is a neat piece of construction.

Figure 9: This telescope is a 12½-inch Gregorian of 342-inch effective focal length, built by A. H. Hearn, Oklahoma City, Oklahoma. The Gregorian is a compound telescope two mirrors -in which the image reaches the eye erect instead of inverted, as in the Cassegrainian.

Figure 10 shows a 12-inch Cassegrainian of effective focal length 192 inches, made by C. R. Tinsley, 3017 Wheeler St., Berkeley, California, and installed at the Mount Wilson Hotel on top of Mt. Wilson, for the use of guests. Weight nearly 1000 pounds. Ball bearings on each shaft. Eyepieces, diagonal, and finder by Kirkham. Telechron drive.

Figure 11: A. E. Dehais, 10 Nixon Ave., Worcester, Massachusetts, chose the fork and roller type of mounting and used an octagonal wooden tube.

Figure 12 shows two smaller telescopes with a 12-inch instrument made by B. L. Harrell, 105 North 10th St., Gadsden, Alabama. Mr. Harrell is collecting photographs of other amateurs' telescopes.

Figure 9: **Hearn, Oklahoma**

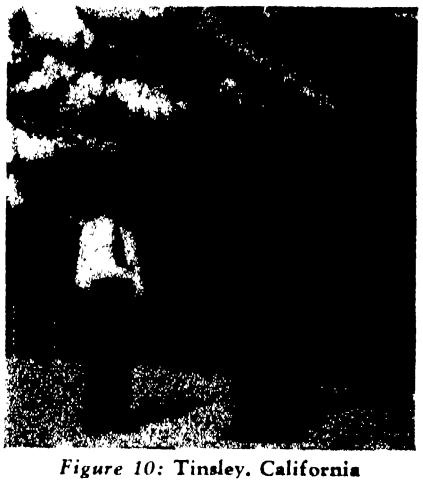


Figure 10: **Tinsley, California**

Figure 11: **Dehais, Massachusetts**

Figure 7: **Katyll, Illinois**

Figure 8: **Jones, Tennessee**

Figure 12: **Harrell, Alabama**

TRAINING PILOTS TO

Accurate Instruments Are Essential . . . Timed Turns . . . "Under the Hood" . . . Landing Blind by Radio . . . Major Problems in Radio Design

"RADIO flying," as the public usually terms the art of following an aviation radio range beam to its source, maneuvering for a landing, and finally bringing the airplane to earth under conditions of storm or fog, carries with it a broader significance, for it involves as an essential preliminary the ability of the pilot to fly "blind"—aided by instruments alone.

Instrument flying combines three elements: controlling the aircraft from information supplied by the instruments, the technique of performing certain definite maneuvers while "blind," and the proper maintenance and calibration of the instruments to insure that their indications are quantitative and not only

Checking a bank and turn indicator to make sure of its rated accuracy

qualitative. To this end, the instruments are accurately calibrated and with their aid radio serves as a positive guide which could not be followed in the absence of instruments.

In order to describe the use of radio in flight training, and some of the developments to be faced by the flight student when at last he becomes an airline pilot, it is desirable to preface those descriptions by an explanation of instrument calibration and a system of timed turns which make instruction in "radio flying" a relatively exact science.

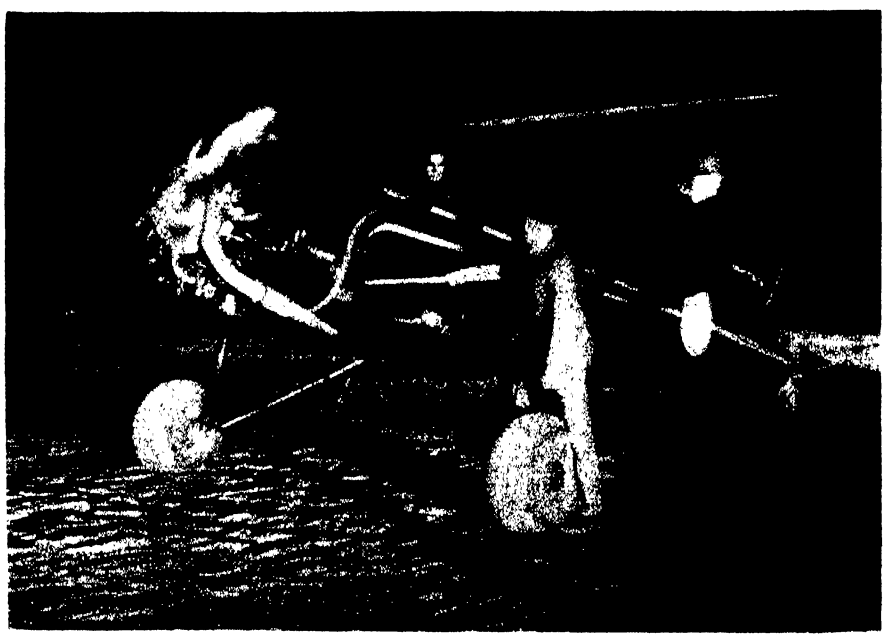
First, the air speed meter of the training plane is carefully installed, checked and calibrated within close limits. Next, the altimeter and rate of climb indicators are calibrated to standard altitude tables in the laboratory. Then the turn and bank indicator is calibrated to a standard rate of turn, so that the turn indicator hand will move its width when the airplane is turning at the rate of three degrees per second, thus enabling the pilot at this rate to complete a full circle turn in 120 seconds. Engine instruments are calibrated against standards to insure their proper readings. The instrument man, the instrument shop, and calibrating methods become, therefore, inseparable parts of instrument flying and apply indirectly to radio flying.

The flying student begins his study of the technique of following the droning on-course radio beacon while yet on the ground, by becoming familiar with the aircraft instruments, their limitations and virtues. He is shown the method of calibration and given necessary instructions. Thereafter, while flying "under the hood," he is required to make all turns by watching the turn indicator hand and checking against time. The importance of this requirement will be seen later when we discuss a specific flight by radio.

In the training planes, the students, on first flights, practice straight flight and timed turns. This, it must be remembered, the student does without viewing the ground. In fact, throughout his first 20 hours of flight instruction, he can see nothing in the darkened cockpit but his instruments. He must get the turn hand in position in 10 seconds, and recover from a turn in the same period of time. Soon he learns three positions of the turn indicator hand: left timed turn position, right timed turn position, and straight for straight flight.

NEXT, he flies definite headings, learning to fly by compass without losing altitude or changing speed or direction. Finally, he considers his clock, timing himself as he executes 90, 180, and 360 degree turns. Having mastered these turns, he next flies the ship from an altitude of 500 to 3000 feet, adding timed spirals to his former timed turns, next moving into shorter turns of 12, 20, 30, and 40 degrees, still using units of time as his guide.

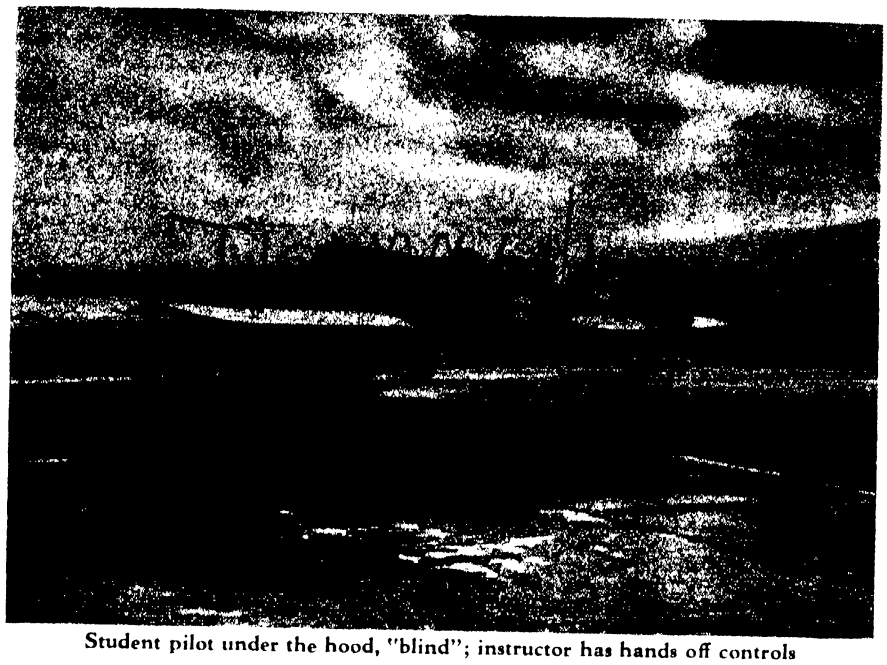
All this is leading up to the pilot's introduction to the radio beam and finally to landing by radio. While not all students actually are permitted to follow the landing beam to a landing, most of



A student pilot checks out for a night flight on the radio range beam

FLY THE BEAM

By ALLAN F. BONNALIE
Director of Technical Instruction, Boeing School of Aeronautics



Student pilot under the hood, "blind"; instructor has hands off controls

Radio receiver test panel for both high- and low-frequency receivers

the advanced student pilots make approaches by radio.

When ready for this part of his instruction, the student, with an instructor in the other cockpit, climbs to 3000 feet by means of two timed spirals, one left and one right, and intermediate straight flight, coming out at last on the original heading. At that level, considered safe for all eventualities, the instructor orders him to find the beam. Here, then, is his real introduction to what in the future will constitute some of his frequent airline experiences.

Not knowing his exact location, he turns on his radio and flies a pre-determined compass course, which he knows will take his plane across the path of a beam. He first encounters repeating "A" signals, then the steady "on-course" signal. But how can he be sure which of the four legs of the beam he has encountered? Simple. He executes a 90-degree right turn to identify the beam. If this turn returns him to an A sector he knows from the "pattern" of the legs of the radio system which beam he has interrupted; he then turns left in a regular timed turn until he swings again into the on-course signal and heads for the cone of silence. The cone of silence is exactly what the term implies, a relatively silent space directly above the transmitting station from which radiate the beam's four branches.

On entering the beam at say, four miles from the field, he knows from instruction that the beam has a width at that point of some 1500 feet, that it will narrow, funnel-like, as he approaches the cone of silence. He very likely wanders from side to side, first into the "A" signal sector, then again into the "N" signal sector, pulling back each time to the steady signal (the center of the beam where the "A" and "N" signals blend) which will lead him unerringly to his destination.

THE cone of silence serves as a definite check on position. When suddenly the signal ceases, the student knows he is over the station, approximately a half mile from the field. Further, he knows that the signals will interchange as he flies out the opposite beam. If, before, the signal "A" came in when on the left, it now will reach him on the right side of the beam. Though it is not always easy to follow a beam, particularly in rough air, this procedure constitutes the elements of beam flying. Practice usually makes the tyro pilot proficient.

But the job is not yet half done. Given the airplane's position over the cone of silence, how will it be brought to earth? While most students are permitted to make only instrument approaches, occasionally one who is in the proper position and is handling the plane correctly is permitted to land "down the beam."

The radio-approach-and-landing work was started at the Boeing School of Aeronautics with the Department of Commerce Bureau of Standards type radio landing installation. A Boeing #40 instrument-equipped biplane was first fitted with the radio landing equipment and experimental antennas for development of the system and the method. Following hundreds of landings, the installation was placed in a tri-motor Boeing #80, a seven-ton passenger-mail plane used particularly for hooded flying by instrument and radio. Many experimental landings have been made with this equipment.

Assume, then, that the large transport plane has flown through the cone of silence, with an advanced student at the controls, headed west at 3000 feet. The pilot knows that the field lies behind him on the left. He holds the course for two minutes, then makes a 40 degree turn to the right, using the timed turn for the purpose, holds this new course for 45 seconds, and then turns left for 70 seconds. This brings him back to the radio beam, and he now follows its easterly course, losing altitude at 500 feet a minute until he levels off at 2000 feet.

As he approaches the airway's radio beam station, a neon light hooked up with the cone-of-silence receiver lights and he continues to hold his altitude, with an air speed of 110 miles an hour. The neon bulb is lighted when the airplane enters an egg-shaped radio field set up by a radio marker at the base

Students calibrating various instruments used in "radio flying"

of the cone of silence, and serves as a further check on position. This field extends upward some 12,000 feet, and is nearly one mile wide at an altitude of 3000 feet.

After passing through the cone, the student pilot continues flying easterly on the beam, along which he made his original approach, for four minutes, maintaining the same altitude and speed. He then switches on his landing beam receiver and makes a timed right turn to pick up the directional beam and the landing beam. That turn is made in one minute, or 180 degrees. Note the time element, for that is highly important.

The pilot has on the instrument panel a combination instrument embodying two hands, one vertical to indicate the directional beam, the other horizontal to indicate the landing beam. When the former is vertical and the latter horizontal, the ship is both on course and approaching the field at the proper altitude. Should either hand swing away from these positions, the ship is too far right or left, too high or too low. Therefore, all the student need do is keep those hands crossed at the center position to continue his proper descending path.

WHILE watching those hands, the pilot soon hears a distinctive high-pitch signal in his ear phones. He now is crossing a vertical marker beacon, and knows he is 2000 feet from the field. Seconds later, he hears a low-pitch signal. This informs him he is directly over the edge of the field. By consulting his sensitive altimeter, he determines whether he has maintained precisely the correct altitude, which now should be of the order of 100 feet.

With these invisible markers behind him, he continues his flight path and very shortly feels the wheels touch the ground. As soon as contact is made, he holds a straight course by watching the turn and bank indicator to insure a stop without ground looping. At no time has he used the altimeter, except as a check against coming in too low, until after crossing the second marker.

While the student may not be aware of the fact, he is making use of the latest equipment and methods provided by the Bureau of Standards and the airlines, consisting of the radio range beacons and vertical marker beacons of two types—the egg-shaped station marker and the vertical markers near the field, and two-way radio communication maintained by the airlines.

By virtue of a combination of visual and aural instruments, the student while making a blind landing need fix his eyes on only one instrument, the combination of crossed hands, except for occasional consultations of his sensitive altimeter. The station marker, which sets up the egg-shaped field and lights the neon lamp, is received on a small, rugged airplane receiver built at the Boeing School. It operates on a frequency of 91 megacycles, or 3.3 meters.

The Bureau of Standards landing system, consisting of the vertical and horizontal beams, is well known. Both beams operate on ultra-high frequencies. The horizontal beam, due to the transmitted power and reflection from the earth, describes on its lower edge a path which curves upward away from the transmitter, thus providing a more positive and surer guide for landings.

Perhaps the vertical markers are of greater interest in that they provide positive indication of the plane's distance from the airport, no matter in what type of weather it may be flying. On encountering the first the pilot hears a 1250-cycle tone, and in the second a 250-cycle tone. Single wires parallel to the ground serve as antennas.

Radio in aviation, whether in training or commercial flying, involves continuing experimentation. Definite problems are recognized, and they can be solved only through careful research. Experience at the Boeing School may serve as a case in point.

For a time we maintained ground-to-plane communication, using the beacon receivers on the planes, through the traffic control transmitter in the field flight house. It soon became difficult, because of other pressing needs for the microphone, to use this for distinctly educational purposes. Experimental work was therefore instituted leading toward perfection of a satisfactory high-frequency transmitter available to flight instructors on the ground.

One of the major problems of aircraft radio is the power supply, particularly for the lighter, instruction planes. In fact, the biggest problem with radio even for transport work lies in a suitable power supply. Our experiments have been directed toward development of a small wind-driven generator, mechanically and electrically tied in with the high-frequency receiver, this unit to be compact, portable, and light enough in weight to permit its use with a trailing antenna, probably from the top of the rudder or possibly from a mast antenna which is part of the unit itself.

FEW students in training today realize the complexities of the radio problems they will face when doing commercial flying. Developments in the offing promise efficient, time-saving communications thought impossible only a short time ago. At least one other landing system, developed in the Army and known as the Hagenberger system, is under trial. This consists essentially of two portable marker beacons, placed in a line at the end of the landing runway. By using a directional Kreuse loop, the pilot tunes in on both after having crossed the first and after several exploratory flights finally orientates himself with reference to the runway. He finally sets his directional gyro and approaches for a landing. No means of positively indicating altitude is yet provided by this system.

Further, visual broadcasting from ground to plane, and possibly from plane to plane, is approaching the point of practicability. This will take the form of written messages, received in facsimile. It consists essentially of a photocell which scans the message to be sent in rows of lines. After amplification, these are transmitted as a rapid series of signals, which, when received, will modify the intensity of the writing mechanism as it traces similar lines. Such a method will remove disputes over messages, but complicate the pilot's work.

No pilot can be said to be accomplished who is not capable of flying a plane by instrument and radio methods. In time of stress and strain, he should be able to utilize both to their utmost worth. By such methods as have been outlined are tomorrow's guardians of the airliners receiving basic instruction which will equip them to meet all conditions of flight with skill and precision.

INTERGLACIAL MAN IN AMERICA

New Minnesota Finds May Date Earlier than Last Glacial Stage . . . Perhaps 20,000 Years Old

By C. E. HAGIE, Ph.D.
Superintendent of Schools, Aurora, Minnesota

FOR years archeologists and anthropologists have been seeking for proof of a glacial age human inhabitant of America. In recent years there have been finds which strongly support the assumption that man did inhabit North America during inter-glacial times. Up to the present time, nothing that has been discovered has been accepted by a majority of authorities as positive proof that man has inhabited America for as long as 20,000 years. On the other hand, it is probably true that most of the scholars in this field of research incline to the belief that man has been here at least that long.

During the past Christmas holiday period the rumor reached me that workmen excavating a road cut had dug up some shiny, black arrow-points. Taking with me a research worker who was attached to my office, I drove immediately to the site. I found that the workmen were excavating in sand and gravel underlying from eight to ten feet of undisturbed glacial till made up of fine clay and rock. The situation was on top of a hill. Mr. Oscar B. Larson, who had general oversight of the road project, gave valuable voluntary co-operation leading to the examination and photographing of the artifacts carried away by the workmen.

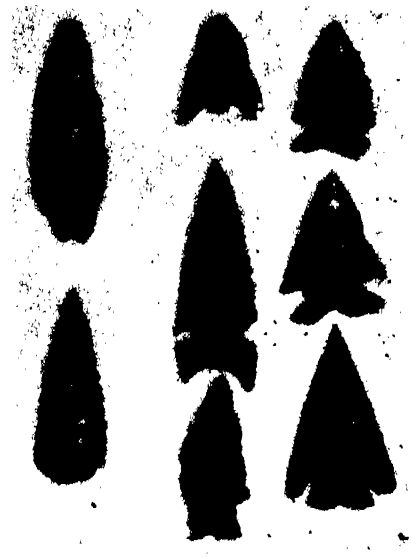
A 4½-inch spear point taken from the site described in the article

The first artifacts to be found had been shoveled up at a depth of two or three feet below the lower limit of the glacial clay, in medium coarse sand. There followed an immediate scramble for possession of the points as souvenirs, which presently led to the point in the excavation from which the shovelful of sand came. There a dozen or more artifacts were dug out and appropriated within the next few hours. As the overlying glacial clay was extremely solid the men dug back under it two or three feet. In this way a number of the artifacts were taken from under the shelf of overhanging glacial till, without disturbing the proof that the eight or nine feet of soil above the artifacts had not been broken through in making a "deep" burial.

THE sand from which the artifacts were taken was somewhat coarser than that of the cross-bedded, water-lain strata by which it was surrounded, immediately underlying the slightly reddish-gray glacial clay. We arrived in time to examine this coarse sand before it had been entirely removed by the workmen in their treasure hunt. Mr. Hill, my research worker, and I, are convinced that the coarser sand represented the filling material of a burial in the stratified sand, at a date before the last glacial period—which will undoubtedly be found to have been the Wisconsin stage, on this site.

Affidavits have been secured from all the workmen who actually picked up artifacts "in place" under the undisturbed glacial till. I arranged for Mr. Hill to remain on the site and check further developments. He excavated the small remaining amount of coarse sand and found one additional artifact, in place and under the overhanging clay shelf (central one in the photograph). This was a broken drill point of milky white quartzite. A few days later the temperature dropped to 30 and 40 degrees below zero, heavy snows followed and the field work had to be discontinued until spring advanced.

With the exception of the drill point, all artifacts (22 now known to have been found) were made from black obsidian and black, fine-textured basalt. Eleven of these are now in the possession of the museum of the Aurora, Minnesota, High School. From a scientific point of view they may represent the most valuable prehistoric artifacts on the continent. If cultures can be expressed in terms of a type of stone flaking, as some apparently imply, these could be classified as transition Yuma. All of them show some evidence of the diagonal flaking from side to side across the face in parallel ridges. Several of them carry out this feature in a very perfect way, while others show it only in slight degree and very imperfectly.



A few of the finds made at the site of the Minnesota discovery

Professor A. E. Jenks, anthropologist, of the University of Minnesota, who is a leading authority on ancient man in America, visited the site, noted the glacial till in place and undisturbed, and remarked: "It looks too good to be true". When the circumstances have been fully verified by the leading authorities in the field of geology the find will have pushed the dating of man's sojourn in America to more than 20,000 years ago.

[*Editor's Note:* Only time and detailed investigation will permit the exact significance of the finds described above to be assessed.]

EROSION CONTROL

FLOODS during the late winter and early spring of this year have brought to the fore once again the necessity for thorough consideration of the flood control program in many sections of this country. In working out the solution, it is not enough to build levees, dykes, and flood-ways immediately adjacent to the rivers; it is necessary to go back to flood sources. This means primarily a study of the retarding effects which forests and plant growth have upon run-off, and of soil erosion which has lost to American agriculture billions of tons of arable earth.

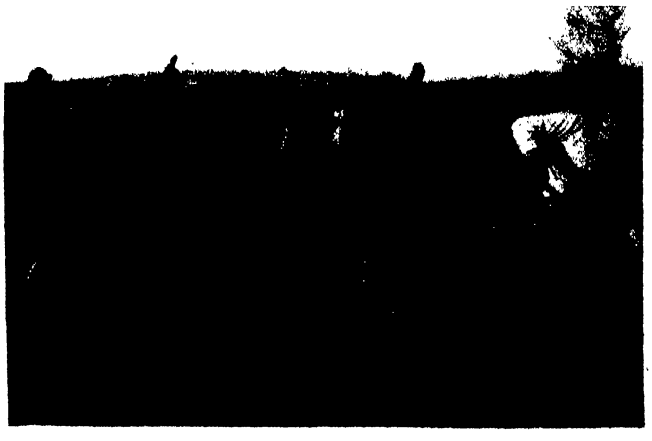
Through the work of the Civilian Conservation Corps, many areas have been reforested recently. The new forest cover on formerly barren hills and slopes has done much to retard the melting of snow and prevent a rapid run-off of water. Other control measures taken under the supervision of the Soil Conservation Service, Department of Agriculture, have aided further. Mr. H. H. Bennett, Chief of that Service, says that: "Our work the last two years in 141 watersheds throughout the country indicates that the volume of run-off water can be

An eroded area typical of many such spots vation, this field has been so badly washed for

Terracing of cultivated fields along contour lines is of first importance in soil erosion control. It is very effective in holding and diverting run-off water, thus preventing loss of the rich and arable soil

In washes of the type shown below, simple brush dams and aprons provide a check against the further loss of soil, and, in fact, rebuild the land with soil and debris

The two photographs below illustrate construction of, and completed, concrete spreaders. These "sluiceways" are designed as outlets for the run-off from terraces, spreading the water into a thin, cascading sheet which will not gouge out a gully



CHECKS FLOODS

requiring control measures. Formerly under culti-
25 years that no vegetation could get started

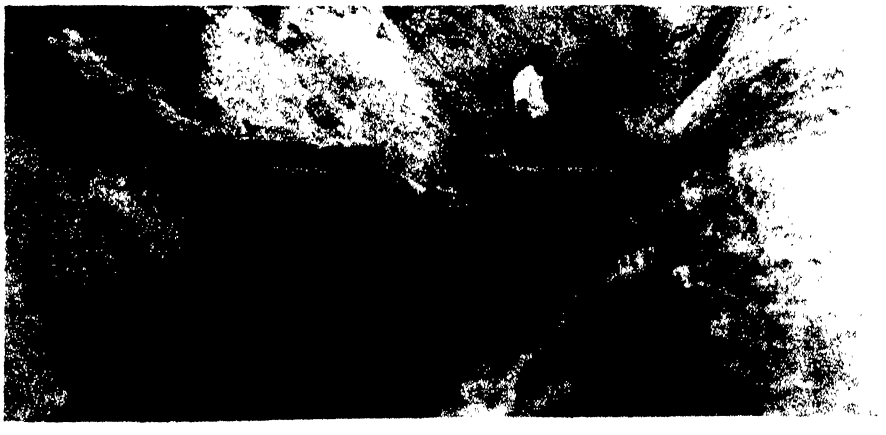
reduced 20 to 25 percent through the use of erosion control methods. This is the margin, in most cases, between mere high water and destructive floods."

Detention dams, dykes, and similar engineering measures are essential to complete flood control in localities where the hazard is unusually severe. This control starts with the proper preparation of the cultivated field, and terracing is being resorted to in many localities where, formerly, heavy rainfall has scoured out entire hillsides.

On these pages are illustrated a variety of dams and other structures which have been designed not only to prevent the flash runoff of water and scouring, but also to provide settling basins for the soil which otherwise would be washed away. In many cases, such barriers have served to rebuild land where great gullies were being formed.

There can be no permanent control of floods, according to Mr. Bennett, until we have control over erosion of entire watersheds. To gain such complete control means that in the future there must be full co-ordination of efforts in cultivation methods, in reforestation, and in the design of control structures.

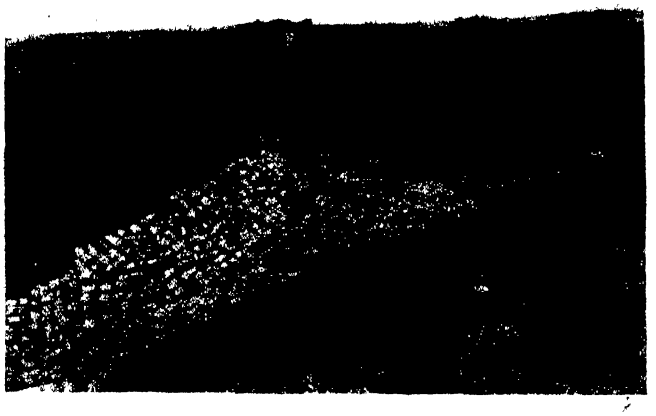
Another simple rebuilder of land is a staunch log dam, shown below, across a gully. Any land-owner could build this easily with materials from his own farm



Above: A series of cemented rock dams is necessary in some cases where the gradient is steep and the erosion is fast

Lower left: A weir-type, low dam of field stones against low posts, with an overflow apron of stones, has been found satisfactory for retarding flow and loss of soil

Below: An apron of loose, heavy stones, overlaid with hog wire to hold the stones in place, prevents the scouring of a hillside where run-off of storm water is heavy



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.
Director of Research, Remington Arms Company

Electric Fly Killer

A NEW low cost, electric, insect destroyer, especially designed for use in food and dairy plants, as well as in the home, has been brought out by Edelman Company of Chicago. This device consists of a container for pyrethrum extract and an electrical atomizer built into one case.

Death to flies

The container holds one half pint of the extract or a sufficient amount to clear out a space of about 18,000 cubic feet. The extract is harmless to humans and pets, does not taint foods, and is non-injurious to furnishings, fixtures, or tableware.

The pyrethrum liquid is supplied as a fluid emulsion, and in use the active pyrethrum oil floats to the surface, from which it is driven at about 160 degrees, Fahrenheit, as a finely dispersed vapor mist. The device is entirely automatic, it being only necessary to plug the apparatus into a convenient light socket. There are no moving parts in the device and it is said to consume only 0.125 kilowatt hours of electricity in treating a space of 18,000 cubic feet.

Bright Nickel Plate

A NICKEL plating process which deposits a film so bright that it needs no polishing has been perfected by Weisberg & Greenwald, New York City. A number of installations are already in operation: plating on brass, steel, and zinc die castings. Deposits produced from this solution are said to have a mirror-like brightness; the brightness increases with the thickness of the deposit, sometimes resulting in covering up minor imperfections in the base metal to a considerable extent. This form of nickel plating is said to be remarkably ductile.

A similar process of producing "bright zinc" surfaces was perfected recently by the R. & H. Division of the du Pont company.—*A. E. B.*

WOOD CROPS

FOREST products are tenth in the big ten of farm crops, outranking 35 other major crops such as barley, beans, rice, peanuts, and sugar. Farm woodlands pay their owners nearly 63 million dollars a year.

Weight Saving in Diesel Construction

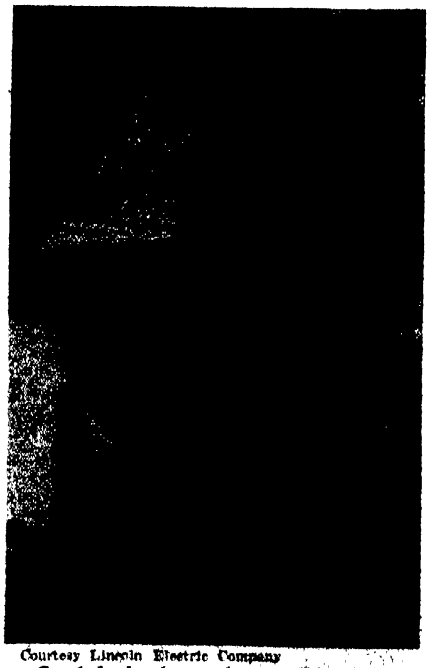
WHAT is probably one of the greatest forward steps in the Diesel engine since its invention was noted recently in England when a new engine, built to replace a unit in a motorship, doubled the power of the vessel yet required no more space than the original unit.

The new engine is rated 4000 brake horsepower at 109 revolutions per minute but actually develops 4400 brake horsepower. Of the double-acting, two-stroke, four-cylinder type, the new Diesel has a bore of 27½ inches and stroke of 47½ inches. It was built by Richardsons, Westgarth and Company for the motorship *Silverlarch* of the Silver Line. The *Silverlarch* is one of two vessels which the owners are having reconstructed by J. L. Thompson and Sons, Sunderland, England, to provide increased speed.

Construction of an engine having such a high ratio of power to size has been made possible by improved design employing steel and electric welding. Major parts, such as bedplate and columns, scavenging air main, crankcase covers, and plates and exhaust pipe, are all built of arc welded steel plate. The use of arc welded steel provided maximum strength and rigidity per minimum size of members and minimum pounds of weight. This advantage enabled the builder to obtain a structure double the capacity possible with a suitable form of cast-iron construction.

The bedplate is of special interest in view of the engine's power and its comparatively low speed. The length of the bedplate is 22 feet 6 inches, width 14 feet, and depth 5 feet 4 inches. It is of the tank-top type.

The bottom plate consists of two lengths of steel plate double butt-welded together longitudinally. To obtain maximum rigidity, the sump is welded integral with the bedplate. The columns consist of a mini-



Courtesy Lincoln Electric Company

Steel bed plate of new Diesel in which weight is saved by welding

mum number of pieces of steel plate fused into one unit by the electric arc. The cast-steel bearing housings are fixed in the bedplate by steel plates welded to them and to the sides and bottom of the bedplate. The welding was done with electrodes and welding machines supplied by The Lincoln Electric Company.

Although the aim of the builder was to obtain a structure of maximum rigidity at moderate cost without any particular emphasis on lightness, the saving in weight was large. The bedplate weighs approximately 33 percent less than would be possible with suitable cast-iron construction. Actual weight, arc welded, is 29½ tons. Weight, in cast iron, would have been 44 tons. Cost savings were also considerable due to elimination of patterns and pattern drawings and to simplified machining.

Centrifuge rotor showing the tiny oil turbines at each end of the shaft; and the two end bearings which house the turbines. Centimeter scale for comparison

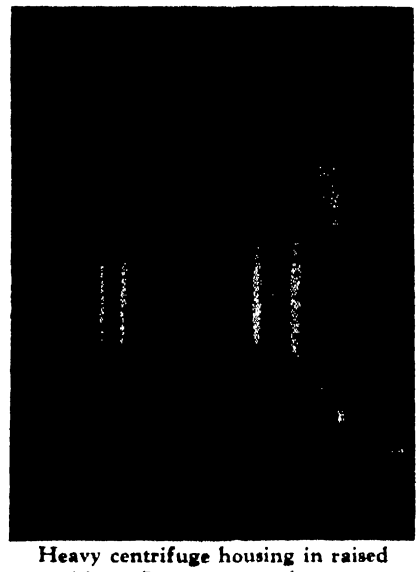
CELLOPHANE

A BAND 200 miles wide to wrap entirely around the earth!—that is the quantity of Cellophane that has been produced during the past 10 years.

250,000 Times Gravity

FOR those people who revel in astronomical figures, a new ultracentrifuge at the du Pont Experimental Station, at Wilmington, Delaware, should hold much fascination. First of all, it is the second of its kind in the world, and the first in this country. It is the largest yet completed for this purpose. The rotor is designed to operate for prolonged periods at 60,000 revolutions a minute, thus creating a centrifugal force of 250,000 times that of gravity. Under such conditions a mass of one pound would weigh 125 tons. The rotor, of heavy steel, has a peripheral velocity of more than 20 miles per minute, or approximately one and one-half times the muzzle velocity of an ordinary 22-caliber bullet.

This machine is the invention of and was built by Dr. The Svedberg, professor of chemistry in Upsala University, Sweden, and Dr. J. B. Nichols, former student of Professor Svedberg, who is now on the du Pont research staff. It is the latest development of Dr. Svedberg's conception 13 years ago of a machine to attain "ultra" centrifugal forces. Since that time, Dr. Svedberg has made machines which have stepped up the attained centrifugal force from 500 times the force of gravity to 5000 times, to 100,000 times, to 200,000 times, and so on until the high point of 1,000,000 times gravity was attained at a rotor speed of 160,000 times a minute. The present machine is slower than that but its superiority lies in the fact that its 60,000 r.p.m. may be maintained indefinitely. It is driven by tiny oil turbines on each end of the rotor shaft, and requires an hour to accelerate to full speed and an hour to decelerate.



Heavy centrifuge housing in raised position. Rotor is in the center

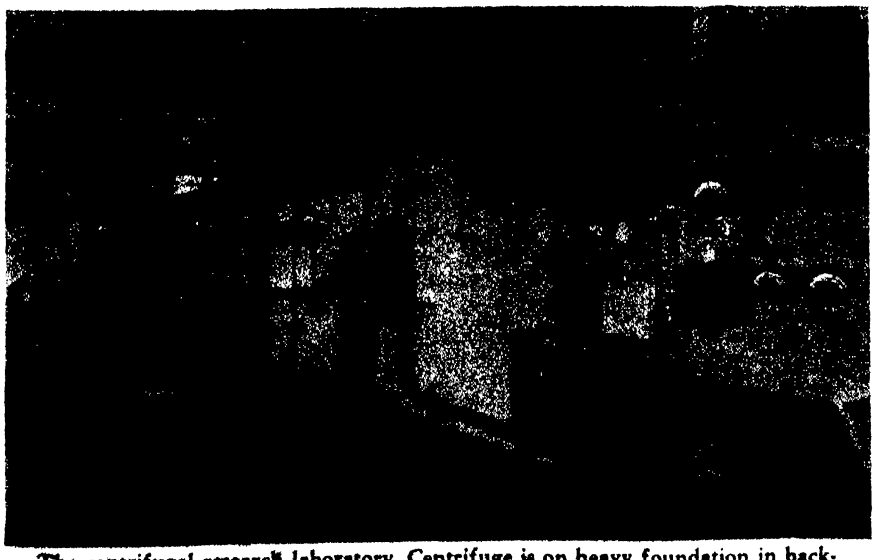
In using the ultracentrifuge, the liquid material to be studied is placed in a small cell inserted in the rotor. This cell has transparent quartz windows, and in the massive steel chamber which encloses the rotor are corresponding windows or peepholes. By directing a beam of light through the windows, the observer can note the effects of the centrifugal force.

If, for example, a solution of a colored substance in a colorless liquid is centrifuged, the observer may look through the windows and see the boundary of the colored dissolved substance move toward the bottom (outer) part of the cell. In order to obtain exact measurements, however, photographs are taken at suitable intervals, and from these photographs the rate of settling of the dissolved substance can be calculated. Knowing the rate of settling and other readily determined characteristics of the system, the size of the particles or molecules can be calculated. In taking the photographs, an image of true size is desired, and errors of parallax must be virtually eliminated; consequently the camera plate is 18 feet from the cell, the camera itself being nine feet long. On the photographs, distances as small as one twenty-five thousandths of an inch are readily measured.

When both the dissolved substance and the solvent are colorless, a beam of light passing through the cell is refracted or "bent," and the amount of the bending indicates the concentration of the invisible dissolved substance in that part of the cell as it settles to the bottom.

The speed of the rotor is measured by means of a stroboscope, which is simply a slotted disk driven at variable but known speeds through which the high-speed rotor is observed. When the rotor and the stroboscope are in step, flashes of light pass without interruption through both openings and the speed of the rotor is equal to the speed of the stroboscope disk times the number of slots it contains.

With the ultracentrifuge, Svedberg and his collaborators have determined the molecular weight (particle size) of various proteins, those substances so important in all living things. Quite unexpected results were found. Thus, contrary to all other kinds of giant molecules, many of the proteins were



The centrifugal research laboratory. Centrifuge is on heavy foundation in background, camera in striped tube, and control board and stroboscope in foreground

found to be homogeneous; that is, to consist of molecules all of the same size. No other molecular weight technique is capable of revealing this information.

Another important fact, the significance of which is not yet clearly understood, is that the molecular weights of the homogeneous proteins are simple multiples of a basic unit, 34,500. That is, for some curious reason, the protein molecule appears to consist normally of 1, 2, 3, 4, 6, 12, 24, 48, 96, or 192 "bricks," each weighing 34,500 times the weight of the hydrogen atom. No homogeneous proteins of intermediate size have been found.

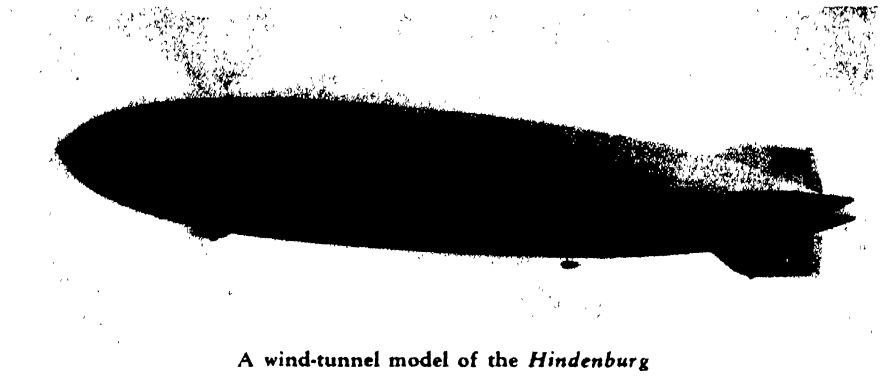
"Just what scientific advances will be achieved with the ultracentrifuge in the years to come is impossible to predict accurately," said Dr. Kraemer, du Pont research chemist. "But we do know that the pioneer work of Svedberg, Nichols, and their collaborators has provided a new tool having exciting potentialities in the field of colloid chemistry, which field includes the chemistry of giant molecules, of which such commercially important substances as cellulose, glue, resins, rubber, and starch are but a few examples."

The "Hindenburg"

THE new German Zeppelin, *LZ-129*, has been christened the *Hindenburg* and has passed its flying tests with perfect success. If the wonderful record of the *Graf Zeppelin* over the South Atlantic is borne in mind, there is little doubt that the same regularity and safety may be expected in the service of the new airship over the North Atlantic.

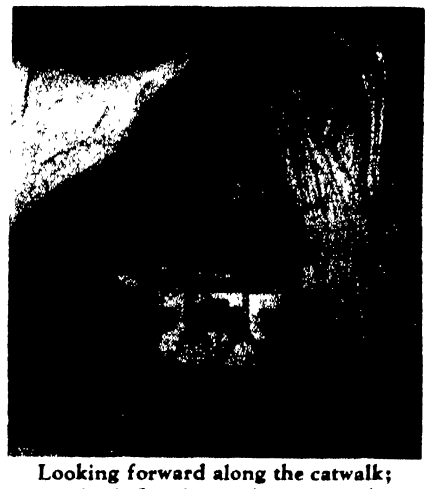
Thanks to the courtesy of W. E. Dörr, chief engineer of Luftschiffbau Zeppelin, the company that constructed the ship, we are able to give a brief description—it is impossible to give a detailed account of a craft of this complexity and size—of the *Hindenburg*.

The most remarkable fact that emerges from Mr. Dörr's statement is the divergence of American and German viewpoint in regard to airship construction. In the United States, the Airship Survey Committee is carefully and systematically investigating the subject of safety, and is carrying out a long program of research to provide a better basis for structural calculations and design. At Friedrichshafen, the Zeppelin company, with 35 years experience in the art and a marvelous record of safety in commercial operation, is perfectly content to build its latest ship on very much the same lines as its predecessors, although many improvements and refinements appear in the new design.



A wind-tunnel model of the *Hindenburg*

There is a striking difference between the *Hindenburg* and the *Graf Zeppelin*, but this is mainly in size. While the *LZ-129* is only a few feet longer than the *Graf Zeppelin*, it has a considerably larger diameter and holds 7,063,000 cubic feet of gas instead of the 3,708,000 cubic feet of the smaller vessel. This huge volume gives the *Hindenburg* the distinction of being the largest airship ever built, far exceeding in capacity the 5,000,000 cubic feet of the *Akron* and the *Macon*.



Looking forward along the catwalk; partly inflated gas bags at sides

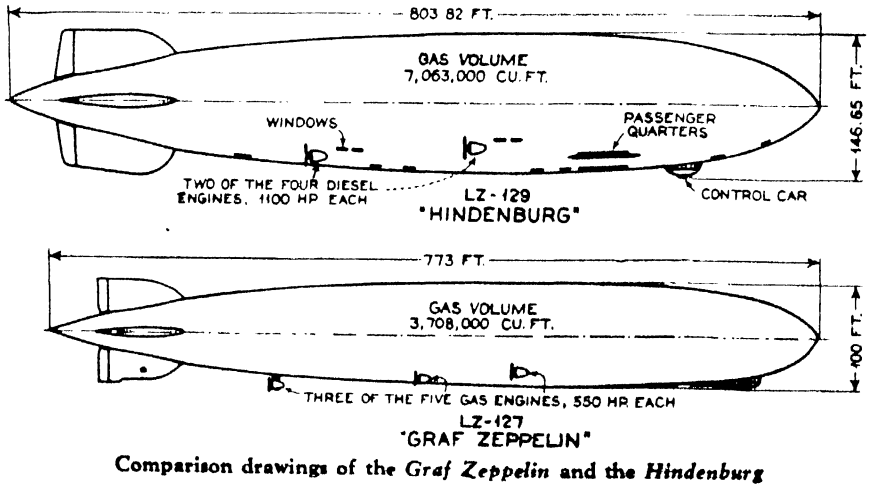
We do not propose to discuss here the almost tiresome question of whether the flying boat or the airship will be the more successful in transatlantic operation, but one thing is quite clear; the *Hindenburg* will be able to carry quite a respectable payload, at a moderate speed, and it will be perfectly capable of making a non-stop flight from Europe to the United States, with a range in miles which will be more than double that required. There will be no question of flying a southerly route via Bermuda and the Azores. The Captain will merely seek a great circle route, with due allowance for weather conditions, between the points of departure and arrival.

***Specification and Main Dimensions of the* Hindenburg:**

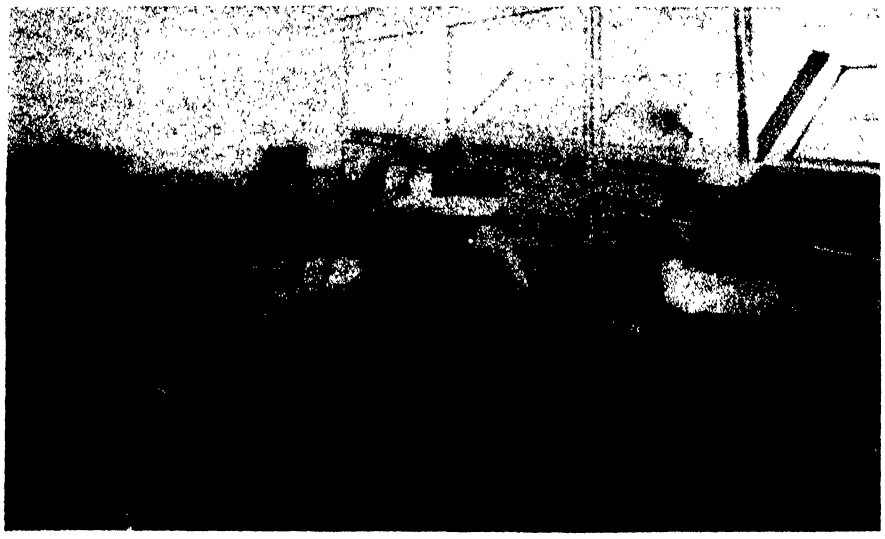
Length, 803.82 feet.
Height, 146.65 feet.
Largest diameter, 135.17 feet.
Fineness ratio (length divided by maximum diameter) 6 to 1.
Total lifting gas volume 7,063,000 cubic feet.
Number of gas cells, 16.
Gross weight with equipment and fuel, 430,950 pounds.
Payload (passengers), 15,470 pounds.
Payload (freight and mail), 26,520 pounds.
Total lift under standard conditions, 472,940 pounds.
Power Plant: 4 Mercedes-Benz Diesel engines of 1100 horsepower each.
Auxiliary Diesel-electric generator engines, two of 50 horsepower each.
Maximum Speed, 84.4 miles per hour.
Cruising Speed, 78.1 miles per hour.
Range at cruising speed, 8750 miles.
Maximum capacity, heavy fuel oil, 143,650 pounds.
Crew, 40 men.
Number of passengers, 40.

Why Was Fineness Ratio Reduced? In one of our illustrations, the wind tunnel model of the *LZ-129* is shown in fictitious flight. The model appears rather stumpy compared with the *Graf Zeppelin*, and it may be asked: Why was the fineness ratio decreased? It appears that, on the whole, the air resistance of the "fatter" airship is less in proportion to the volume displaced, and the shorter length also means less bending moments to be resisted by the girders. These are good and sufficient reasons for the change. But a long airship is apt to be more stable, a shorter one more controllable. There was some little doubt in the designer's mind as to whether there would be enough stability. From the flight tests, however, the conclusion was reached that just the right compromise between stability and maneuverability had been achieved.

Manual Control: The steering of a steamship is associated in our minds with a "donkey engine" or some similar contrivance for increasing the power of the helmsman. It has often been stated that with very



Comparison drawings of the *Graf Zeppelin* and the *Hindenburg*



The passenger lounge and promenade, starboard side, on the *Hindenburg*

large airships a form of servo-control would become necessary. But the *Hindenburg* is still manually controlled from two large wheels in the steering room, with cables over pulleys going to the rear of the ship. The secret lies in the very delicate aerodynamic balancing which has been secured in both the rudder and elevator surfaces.

Fire Precautions: Americans interested in airship development have been somewhat disappointed by the length of time consumed in the construction of the *Hindenburg*, and the delays in final completion. Mr. Dörr explains that this was due to some important and fundamental changes in the design, related mainly to safety. In the original plans, which were for a model termed the *LZ-128*, gasoline engines were specified, with either hydrogen or "blaugas" for the gas cells, with the hydrogen or blaugas to be burned in the motors as loads became lighter and gas had to be valved out.

The present airship power plant uses Diesels, burning heavy fuel oil; also, while hydrogen is being used on the first flights, provision has been made for internal, relatively small cells of hydrogen, surrounded by helium gas. The fire hazard is thus greatly diminished and the hydrogen can be used for maneuvering, thus avoiding losses of the expensive helium. Other precautions against fire in the form of numerous and well placed fire extinguishers are employed. As a result, passengers will enjoy the privilege of a smoking room—a boon to restless persons on a long trip.

Certain additional precautions against fire have been taken in the smoking room. Its walls are covered with a veneer of pear tree wood, which is almost as non-inflammable as asbestos. The doors to this room can only be opened from outside, or by a push button at the sole command of the steward. This feature is counted upon to prevent passengers from leaving the smoking lounge while carrying lighted cigars or cigarettes. The door is also said to form an "air lock." The ash receivers are also of a special type. When a lighted cigarette is thrown into one of these receivers the burning stub is automatically extinguished!

Power Plant: The four Mercedes-Benz Diesels are the most powerful high-speed Diesels ever built. It took time and trouble to develop them, and therein also lay part of the delay. In American practice, reversible pitch and swiveling propellers have been employed. The swiveling enabled the crews of the *Akron* or *Macon* to place the propellers in a horizontal plane of rotation, to

One of the power gondolas

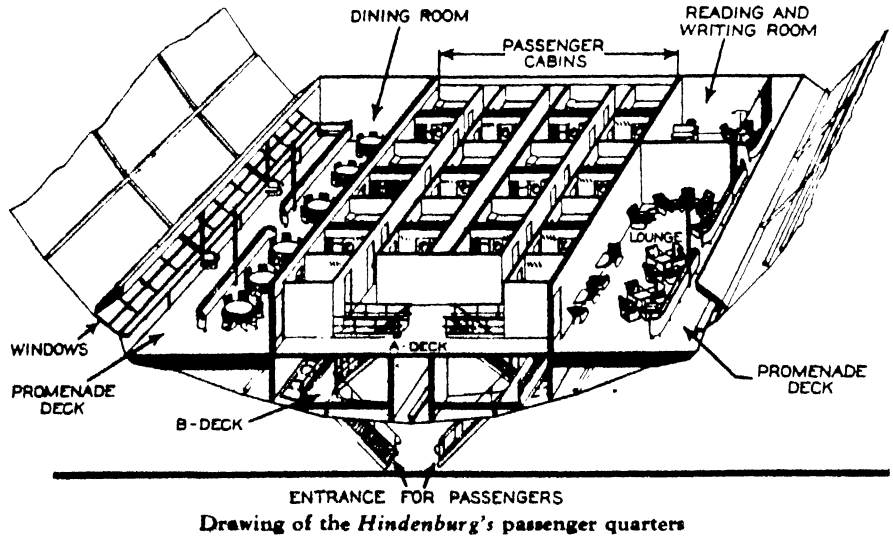
assist in up and down maneuvering. With the Diesels of the *Hindenburg*, no such complex mechanism is required. The engines can be reversed; the swiveling feature is a loss which is probably compensated for by the greater reliability of a simpler drive.

On the *Graf Zeppelin* there were six power eggs or gondolas of 550 horsepower each. On the *Hindenburg* there are only four units, but of a greater total power. One of the photographs shows the mounting of these power gondolas, as well as some of the tanks mounted at the side of the lower keel which runs the entire length of the ship. Some 135,000 pounds of heavy fuel oil is stored in tanks along the keel, suspended on the sides of the cat walk and easily accessible. These tanks are connected to a distribution manifold.

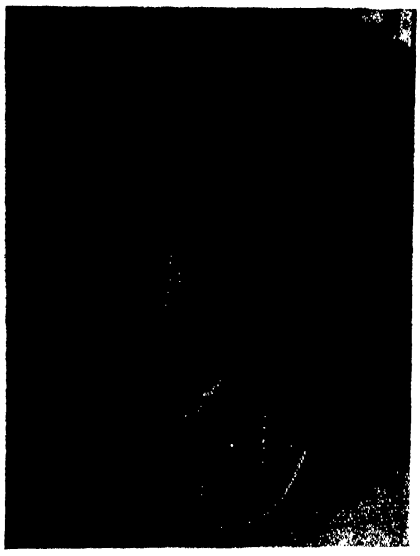
Landing Wheels: In the United States we have come to believe that mooring masts and other mechanical ground handling devices are absolutely indispensable for airship work. Experience with the *Graf Zeppelin* in out-of-the-way parts of the world has led the Germans to the conclusion that an airship must be capable of making "manual" landings; that is, without the aid of a mooring mast. To facilitate "manual" landings, the "buffer" or "bumper" bag commonly placed under the control car and the lower fin has been replaced with two large pneumatic tires, approximately four feet in diameter, mounted on swivels so that they may be swung into any desired direction. These landing wheels can be retracted in flight to diminish head resistance.

Structure: Mr. Dörr emphasizes the fact that the structural design has remained substantially unchanged. The girders have been merely enlarged in section and an aluminum alloy of even higher strength than formerly has been put into use. The girders are of the now familiar triangular trussed type. There are 15 main transverse rings, to house the 16 gas bags, with subsidiary rings placed halfway between the main rings which have 32 angles. The main rings are braced by a transverse wiring system, the wires being connected to a central girder, and by a cat walk which passes through the gas cells.

At the bottom of the ship there is provided a large main girder, which also serves as the main corridor or cat walk, providing accessibility to all parts of the ship and communication between the navigating quarters forward and the passenger quarters farther aft. Another of our photographs gives a view looking along the cat-walk keel towards the nose. The gas bags, shown partly inflated in the photograph, are held in position by wire meshing. Goldbeater's skin is no longer employed for the gas bags;



Drawing of the *Hindenburg's* passenger quarters



An airplane fuselage used in experiments in deliberate nosing over

it has been replaced by a special synthetic material which has no greater permeability to gases and is very much cheaper and easier to obtain. The outer covering or envelope is a cotton fabric coated with cellulose dope, and so pigmented as to be least affected by the sun's rays. Each of the gas bags is provided with its own safety valve, and all the bags can be simultaneously or separately controlled from the navigation cabin. A diagram of the gas bags and their valve controls is mounted in the pilot's car, with numbering corresponding to the various control handles.

A Central Electric Station: Amidships, inside the outer envelope or structure, is located a central electric station, a very important part of the airship. In two separate compartments, there are housed two Diesels of 50 horsepower each, with electric generators of equal capacity; transformers; batteries; and appurtenant equipment. The central station provides power for the motors used to wind up the radio antennas, the motor of the refrigerating system, the elevator used to haul up food, power for the kitchen, and so on. The complexity and completeness of the electrical installation is equivalent to that which would be found in a completely equipped and air-conditioned office building.

Control Car and Passenger Accommodations: The control car is located forward and is completely separated from the passenger quarters. Its dimensions have been held down to a minimum. Rudder and elevator wheels, instrument board, central telephone station, and the valve control system are located in the control cabin.

Quarters are provided along the lower main corridor for a ship's crew of 46 men. These quarters are divided into three groups: the officers' quarters, with accommodations for 12 men, are located above the control car forward of the passenger quarters; deck force quarters with accommodations for 22 are just aft of the passenger quarters; the machinists' quarters with 12 bunks are placed farther aft near the Diesel power plants.

The passenger quarters, located aft of the control cabin, are laid out to accommodate 50 passengers. The quarters are confined to one bay of the airship (that is, between two main rings), are entirely within the ship's hull, and are constructed on two levels. There are 25 staterooms, each of which contains two berths; four public rooms—dining room, lounge, writing room, and smoking room; promenades; kitchen; officers' and crew's mess rooms; bar; bath; toilets; and showers.

An Exciting Experiment: From the above description it will be seen that in the design of the *Hindenburg* everything possible has been done to secure safety, navigability, and comfort. The speed of the ship will be the highest ever attained by a commercial airship. It will be in the hands of the most experienced officers and crew. Therefore the proposed transatlantic service will be conducted under the very best conditions. Now we shall see a truly exciting experiment, the outcome of which will give the answer to the question: Is airship service across the North Atlantic a commercially practical undertaking? The experiment will be all the more interesting since the flying boat services across the Atlantic are also being organized so rapidly and should be in operation soon.—*A. K.*

Experiments in Nosing Over

THE Army Air Corps photograph shows a specially designed cradle which enables the pilot deliberately to nose over a mock-up of a single-seater pursuit fuselage.

Directly over head, a heavy beam reinforces the cabin from front to rear. A seat adjustment of eight inches range is provided so that pilots may raise themselves until their helmets are within one or two inches of a sponge-rubber padding at the top of the cabin. With this apparatus, a systematic investigation will be made of what happens in a nose-over airplane accident.—*A. K.*

REVIVED HEARTS

SIXTY-THREE human hearts have been made to beat again after being removed from the bodies of persons who have died. The object of these experiments, by Dr. William B. Kountz of St. Louis, was to learn more about human hearts and how they function, both in health and sickness—information which cannot be obtained by observation of animal or chicken hearts.

Tetrone B

A NEW industrial organic chemical which is notable for its strongly basic properties which enable it to dissolve wood pulp and cellulose as well as metals and their oxides, has been announced by Rohm and Haas, under the name "Tetrone B." Chemically speaking, it is a tetra-substituted ammonium hydroxide, non-volatile, and as strong a base as sodium hydroxide.

Tetrone B is of particular interest as a solvent for wood pulp and cellulose, and appears to be unique in its ability to dissolve cellulose without the intermediate formation of an ester or ether. It also acts as a solvent for dyestuffs, forming salts which have altered and modified solubilities in solvents or aqueous solutions.

Since Tetrone B is a strong organic base it is also of interest for the saponification of oils, fats, waxes, and gums. It is much more soluble in these products than the inorganic hydroxides. A number of new and interesting salts which have been prepared are the carbonates, phosphates, resinates, silicates, xanthates, and stearates. These salts show distinct properties, and for many applications have advantages over the corresponding alkali metal salts.

In synthetic work Tetrone B is of special value in the preparation of new accelerators, antioxidants, detergents, and pharmaceuticals.

Tetrone B is available in a 40 percent aqueous solution and may be supplied in various organic solvents for special problems.—*A. E. B.*

Angle Trisection

DUE to an error in proof-reading, the exponent 3 was omitted from the end of the tenth line in the second column of page 228 of the April number, containing an article on the trisection of angles. This exponent should be added by those who are using the article for instruction purposes or saving it for future reference. This will make the right-hand side of the equation read: $4 \cos^n$.

Swordfish Stabs a Boat

THE Academy of Natural Sciences of Philadelphia makes public the accompanying remarkable snapshot of a swordfish puncturing a 14-foot dory with its "sword." So far as is known, this is the only photograph of the kind ever made.

The attack took place in the Atlantic ocean 120 miles southeast of Martha's Vineyard, Massachusetts, and is reported by Captain Ira Abbott, of Yarmouth, Nova Scotia, who at the time was sailing master of a yacht out of New York, as follows: "We harpooned the fish shortly after sighting it, and put the dory out with one man in it to bring the fish alongside the larger craft. I noticed he was having considerable trouble to get the fish alongside, so expected something like that to happen, so I was standing by with my Kodak ready to get a picture. I saw the flash of the fish in the water as it approached the dory and pressed the trigger

A swordfish turns aggressor

in time to get the picture as you see it. A few seconds after this picture was taken the fish made another savage lunge at the dory and ripped one plank entirely out, sinking the dory. We got the man all right, and shortly after landed the fish, weighing 350 pounds."

Railroad Inventions

EIGHT great inventions which stand out as mile-stones of railroad progress during the 19th Century, and which are familiar to everyone today, were not originated by railroad men; in fact, most of the inventors belonged to callings remote from transportation of any sort. This significant fact was brought out in a recent address by Dr. C. M. A. Stine, Vice President of E. I. du Pont de Nemours & Company. His citation of these will bear repetition.

The land telegraph, which found its widest use in railroading, was invented by Wheatstone, an English professor of philosophy, and by Morse, an American artist. Pullman, inventor of the sleeping car, was a street contractor in Chicago. Eli H. Janney, who patented the first automatic car coupler in 1868 (thereby eliminating the primitive link and pin method which maimed or cost the lives of many trainmen) was a clerk in a dry goods store. The automatic block signal system was originated by Thomas Seavey Hall, a retired textile manufacturer. Westinghouse was a youngster of 23 when he invented the airbrake, with no experience except in his father's carpenter and machine shop. The vestibule buffer was invented by Hosea W. Libbey, a physician and sanitarium proprietor. The first electric locomotive was designed in 1847 by Moses G. Farmer, a school teacher. Finally, the cinder deflector was invented and patented by the Reverend Adam Sox, a Lutheran minister.

PAPER

THE United States uses more paper than all the rest of the world combined, our total being an average of ten million tons per year.

Wrist Meter

JUST about the neatest trick of the year in men's watches is the Pierce-Chronograph, a combination wrist-watch, stop-watch, telemeter, and tachometer. These four different functions are combined in one compact, practical, and wearable unit.

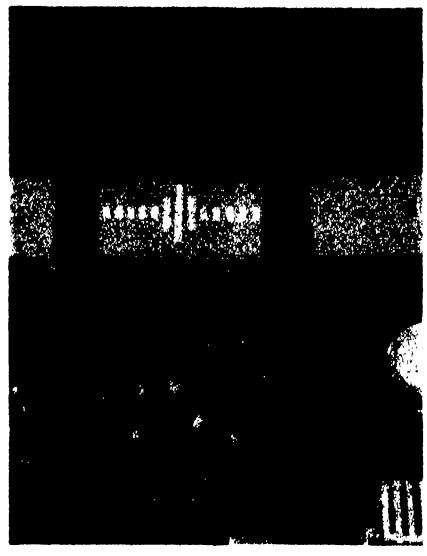
As a stop-watch, the Pierce-Chronograph will time in seconds and fifths of seconds. As a telemeter, it will indicate the distance away from the observer of light or sound. (For example: at the flash of lightning, press the button on the side of the watch, setting the sweep-second hand in motion. At the sound of thunder, press the button again. The number of *miles* away the storm is from the observer will be indicated.) As a tachometer, the Pierce-Chronograph will indicate the number of miles per hour an object is moving.

Versatile wrist stop-watch

Thus, this "watch-plus" is applicable to almost every known sport or sporting event besides its many specialized uses in radio work, navigation, scientific research, aviation, and so on.

New Visual Reed Tuner

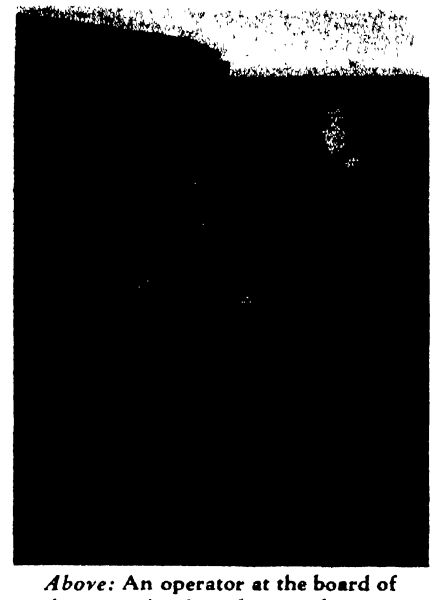
THE entire musical industry will be interested in a new semi-automatic visual reed tuner developed by Victor H. Severy,



a well known engineer of Los Angeles, California. The National Dobro Corporation, manufacturers of fretted instruments and electrical guitars, will display the reed tuner in their Chicago offices.

The tuner tests accordion and harmonica reeds electrically, shows exactly how many vibrations they are out of tune, and makes it possible to bring them to within 1/20 of 1 percent of the accurate pitch. All tuning and adjusting on the tuner is done by sight, so that the operator's hearing ability for surrounding noises makes no difference to the result. The operator is seated at a small desk, with a series of light panels mounted perpendicularly facing him. On the table is a fine grinding machine so delicate that the operator can remove the smallest possible amount of metal from the reed. The reed is attached to a resonator chamber of the same actual dimensions as the instrument, so that it is tuned under the same conditions as it is later played.

In operation, the tuner dials in the number or frequency desired, and the reed is made to vibrate. The control which makes the reed sound also lights one of the perpendicular panels. A calibrated scale shows exactly how much the reed is too slow or too fast; in other words, too flat or too sharp. A slight touch of the operator's hands corrects the variation and a second test shows whether the reed is made perfect. Since the entire operation is almost automatic, all human equation is taken from one of the most delicate operations in the manufacture of reeds. In production, this tuner greatly increases efficiency and quality of product, so that it will mean more economical and better reeds.



***Above:* An operator at the board of the new visual reed tuner for musical instruments. *Left:* Close-up of one of the lighted indicator panels**

What Is This New Oil Good For?

"VISCOUS oil," a new petroleum product, resembles clear, transparent honey, but is so thick and sticky that the liquid can scarcely be poured from a bottle. With substantial quantities available upon demand, petroleum engineers are speculating on possible uses for an oil which is so sluggish that it measures, at 100 degrees, Fahrenheit, as high as 144,000 on the Saybolt scale of viscosity.—*A. E. B.*

Fingerprint Differences

THE recent claim that fingerprints of two individuals have been found to be "almost identical" is refuted by John Edgar Hoover, director of the Federal Bureau of Investigation, United States Department of Justice.

A report from the state of Washington recently credited two men with having fingerprints "almost identical." "The fingerprints of the individuals in question have been examined by the identification experts of the FBI who have pronounced the impressions as readily distinguishable from one another," Mr. Hoover stated. "Such incorrect reports which may tend to shake public confidence in fingerprint identification as an accurate science, should be refuted as soon as possible."—*Science Service.*

The World's Poor Thanks

DEWAR'S earliest publication of the idea of a vacuum vessel dates so far back as 1874, and the suggestion that he was anticipated has no justification: Dewar gave his invention of the vacuum flask freely to the world, and never made a penny by

it, though he might have realized a fortune. If only, as Lord Rayleigh remarked, vacuum-jacketed vessels had come to be called Dewar flasks instead of Thermos flasks, their inventor's fame would doubtless have penetrated to a very wide public.—Douglas McKie, in *Nature* (London).

Lightest Metal

A METAL 10 percent lighter in weight than any previously known has been prepared by the Bartol Research Foundation. It is known as "Lithium Six," indicating that it is an isotope, or light form of lithium metal. While no immediate practical uses for such a metal are evident, the discovery is considered important by scientists who predict numerous potential fields of use.—*A. E. B.*

Water to Burn

OCCASIONALLY conditions occur which reverse the usual practice of generating electricity by steam and make economical the generation of steam by electricity. This practice has not been unusual in certain districts in the Alps and Canada and on the Scandinavian peninsula, where water power has been abundant and cheap.

Less well known is the fact that for the past two years this same practice, on a large scale, has been carried on in our own country by Puget Sound Power & Light Company. This company furnishes electric power, generated largely in its hydroelectric plants, to the major part of western Washington, and also supplies a central steam heating service in the downtown area of Seattle.

The company's electric generating capacity was supplemented a few years ago by the construction of the Rock Island power development on the Columbia River which is essentially a run-of-river plant with little storage capacity. In order to utilize power which could not be absorbed at certain times and would otherwise be lost as water over the dam, an electric steam generating unit was installed in one of the boilers at the steam plant. This initial unit for the generation of steam by electricity proved so successful that a year later a second one was installed.

Since the installation of these two units, which cost 29,000 dollars, more than 180,000,000 kilowatt hours of dump power have been used, thereby saving 100,000 dollars which would otherwise have been spent for coal.—Stone & Webster *Bulletin*.

AUTO PAINT

IN 1913 it took six weeks to apply the 22 distinct coats of old-style paint and varnish to the automobile body. Now the motor car body can be finished from the raw metal out in a single day.

Mechanical Innovations on "Queen Mary"

BESIDES being one of the two greatest liners in the world, the Cunard White Star superliner, *Queen Mary*, shortly to arrive in the United States, has many modern features. While the most striking exterior mode adopted by the *Queen Mary* is her cruiser stern, within the ship are a number of innovations.

The colored lighting system in the main ballroom and the veranda grill is based on a new invention, hitherto used only on land, whereby the orchestral tone will automatically control the color tones of illumination. By use of this, the color and volume of the lighting will be automatically varied in harmony with the pitch and volume of the music.

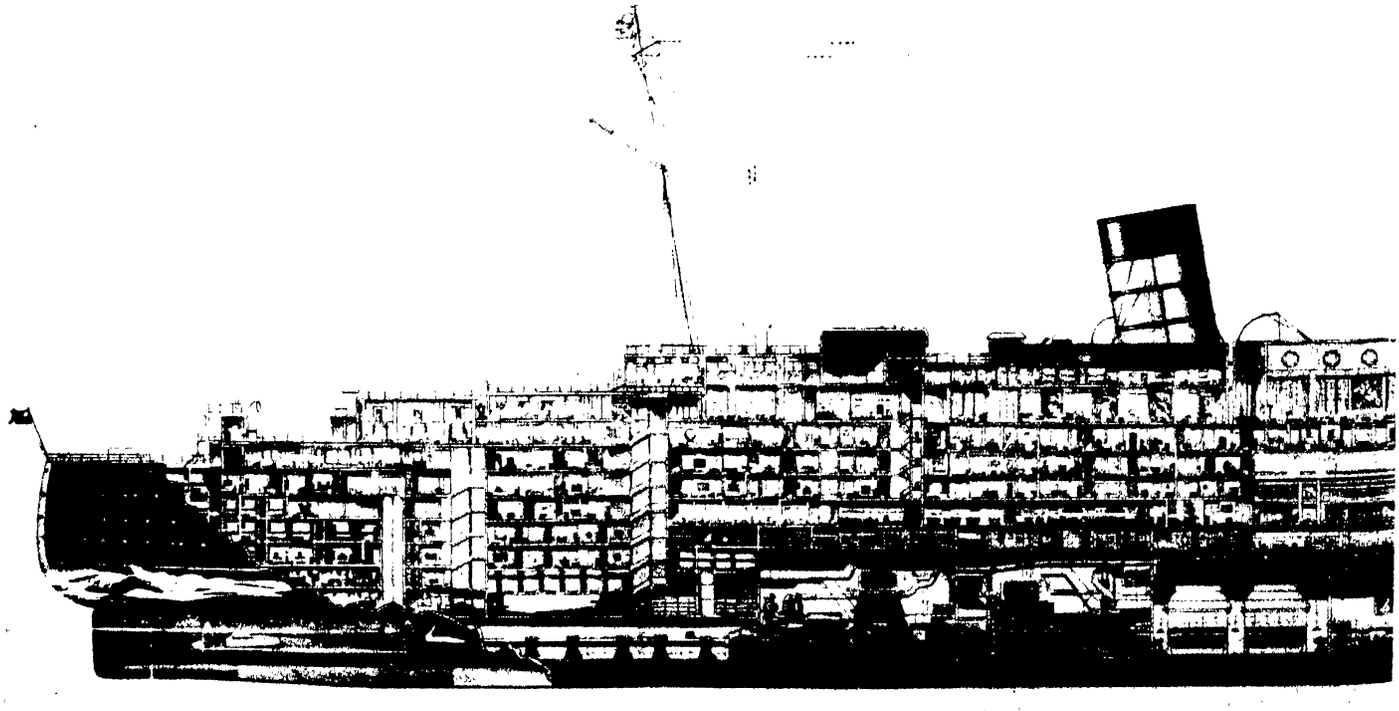
A special kind of vacuum tube, similar to a radio tube, governs this relation of light and sound, and remarkably smooth flexibility of control is obtained. By simply operating a "sound" push button connected with the dimmer, microphones and amplifiers are automatically brought into action. The microphones transmit the music as an audio-frequency impulse to the amplifiers, then an electric filter divides the current into three channels, so that the low-, middle-, and high-frequency notes picked up by the microphones govern the individual banks of colored lamps.

British engineers say that the *Queen Mary's* radio equipment is more powerful than that in any other ship. Concerts, speeches, and interviews, it is expected, will be broadcast regularly from the ship's public rooms.

The complete radio system will employ 11 short, seven long, and five medium wavelengths, besides nine for radio-telephony. By means of radio-telephone, passengers may hold private conversations from their staterooms with any person in any part of the world where telephone links exist. Speech scrambling will insure privacy.

There will be no interference with these telephone conversations while the various radio telegraph channels are in operation. The *Queen Mary* is equipped with nine separate aerial systems tied in with a main aerial 600 feet long; there are also an auxiliary wire with a 150-foot span, three short wave aerials, three receiving antennas, and one emergency aerial. A power plant having an output of 70 kilowatts will supply electric energy for the equipment.

To permit simultaneous transmission and reception of signals without mutual interference, the transmitting station is located 350 feet farther aft than the receiving station. The transmitting station contains four large transmitters, each of which will be capable of maintaining continuous communication with both sides of the Atlantic throughout the voyage. The ship's lifeboats are all equipped with radio.



A sectional drawing of the *Queen Mary*, showing many of the

If the duplicate generating plants for the radio plant should ever be put out of action, a complete emergency station, operated entirely from the ship's emergency lighting supply or from storage batteries, will be available.

The *Queen Mary* also has made advances in air-conditioning over systems prevailing in any other ship. By means of an immense plant, the ship will manufacture her own weather below decks, and passengers may control the temperature of their own staterooms. The air in dining rooms will be kept constant at any desired temperature and humidity, irrespective of weather conditions outside, and thus passengers will be able to dine, dance, read, rest or sleep in cleansed air.

For the first time on any ship, all elevator winding engines on the *Queen Mary* are identical, with interchangeable parts; thus carriage of spare parts is reduced to a minimum. The Otis Elevator Company has installed 21 elevators on the ship as follows: seven for use of cabin class passengers, two for tourist passengers, two for third class passengers, two for baggage, three for service, three for stores, one for engineers, and one for engine room stores. The speed of these elevators will be 200 feet per minute. Openings will be protected by center opening, self-closing, metal doors, which have the advantage of allowing the maximum width of entrance.

The *Queen Mary* will sail from Southampton on May 27 on her maiden voyage to New York, arriving June 1.—*Freeman Cleave.*

Blood From The Dead

BLOOD from the bodies of those who die suddenly—in automobile accidents, by electrocution or by drowning, for example—is being used in Russia for transfusion in human beings. Almost 1000 transfusions of blood from the newly dead have been made at the surgical clinic of the Institute Sklyfasovsky, Central Emergency Hospital, Moscow.

S. S. Yudin, surgeon-in-chief, describes the striking results obtained in these cases and the technique employed in transfusion in *The Journal of the American Medical Association.* Blood must be obtained from six to eight hours after death. The recipient of the blood is safeguarded by serologic tests of the blood, a bacteriologic check-up and a careful autopsy.

In those who die suddenly, the blood remains fluid and can be preserved at low temperatures for more than three weeks, the Russians have found. In its healing effects, this blood does not differ from the blood of living donors. As sources of supply, Dr. Yudin suggests victims of traffic accidents as well as hospital patients who die from coronary thrombosis and angina pectoris. The blood is warmed to body temperature by placing a flask of it in warm water. It is then passed through a gauze filter into the vessel from which it is to be transfused.

The advantage of the method is that there is no loss of time in acute emergencies, for it is unnecessary to call in a blood donor. Another valuable feature is that blood from the same cadaver can be used for repeated transfusions in the same patient. Sometimes several transfusions are necessary during a single operation.—*Science Service.*

Rubber Lined Pipe

A 300-foot unit of 16-inch rubber-lined pipe has recently been installed by the B. F. Goodrich Co., in a large southern pulp mill for handling cellulose material in the presence of chlorine in water solution at normal temperatures. This material was previously conveyed by means of 24-inch wooden troughs which were subject to continual repairs and had to be completely replaced every three years. The 16-inch rubber-lined pipe has required no repairs during its eight months of operation and it has increased production over the 24-inch troughs. In view of the fact that similar installations are still in operation after more than 10 years' service, the life of this equipment is indefinite.—*A. E. B.*

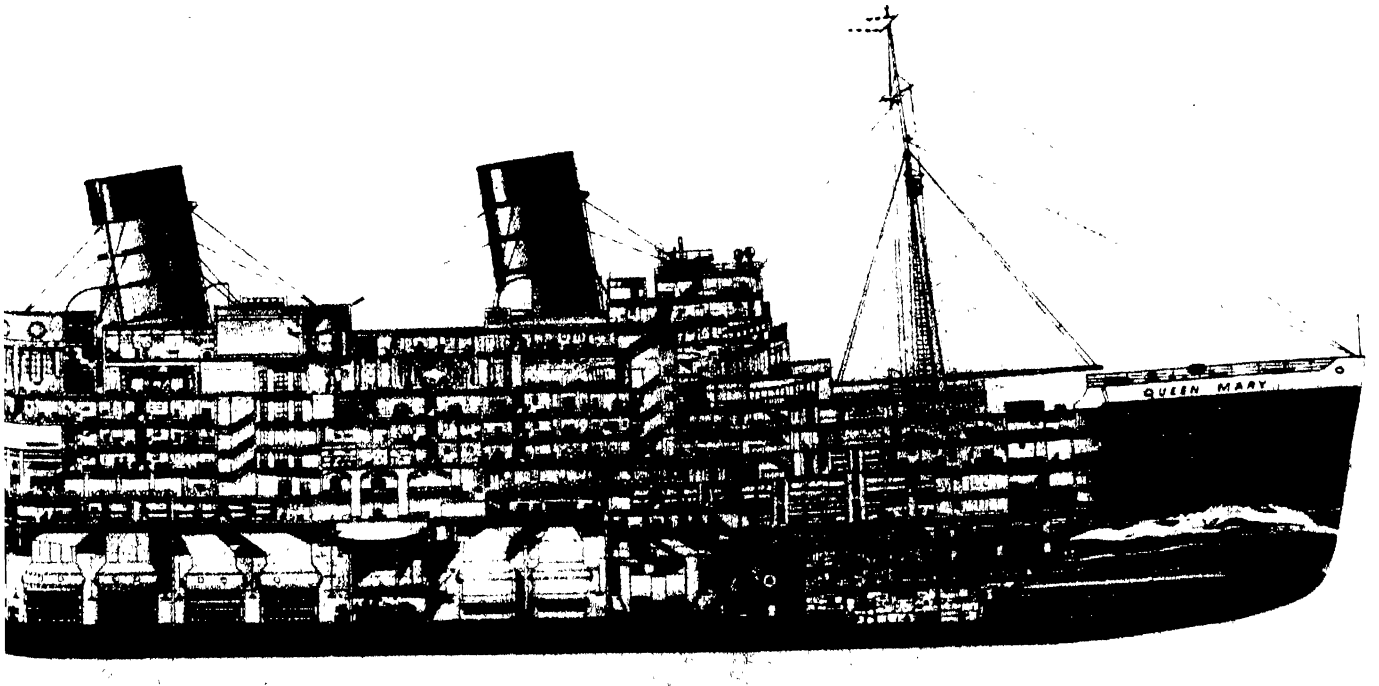
GAS SIEVE

SOLID metal, strange as it may seem, is used as a sieve for hydrogen. The metal is heated to cause it to expand and open the spaces between the atoms; then the tiny hydrogen atoms rush through like water through a basket.

Useful Paraffin

OF the many waxes that are finding more and more application in industry, none is more versatile than paraffin. It has a convenient melting point, will bend, is tenacious at ordinary temperatures, does not deteriorate, is impervious to water at atmospheric temperatures, and has a high dielectric strength.

Bureau of Mines Bulletin 388 reveals that it is used extensively in the manufacture of candles; the impregnation of waxed papers; the coating of paper cartons (butter, cheese, ice cream), drinking cups, milk bottles, and milk bottle tops; electrical insulation; waterproofing; the impregnation of match tips; floor and furniture polishes; laundering; the protection of preserves and jams from fermentation; coating for cheeses to improve their appearance and to prevent mold, evaporation, and shrinkage; the lining of butter tubs; coatings for beer vats and barrels (vinegar, cider, alcohol, whiskey, molasses, and sauerkraut); coatings for meats, sausages, and other products which must be prevented from drying; protective

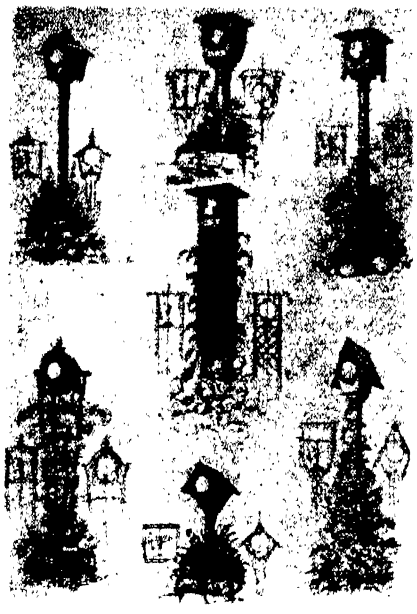


interesting details of her equipment discussed in the text

wax dressings for burns; the manufacture of artificial flowers; etching glass; miners' lamps and marine bunker lights; waxing yarns in the textile industry; stuffing or loading for leather in tanneries; and for numerous other materials and purposes.—*A. E. B.*

Garden Lighting Sources Beautified

THE artistry of garden illumination, now bringing out the depth and color of a blue spruce, now painting the delicate de-



Seven forms of decorative housings for garden illumination equipment

tails of a rock garden, or shimmering into rose and azure in a fountain spray, has met with the enthusiastic approval of landscape architects.

But the manner in which some lighting equipment is located in the garden to obtain these effects tends, architects believe, to destroy the appearance of an otherwise beautiful garden because the source of light is so much in evidence.

With this architectural criticism in mind, J. W. Gosling, designer at the General Electric illuminating laboratory, set out to further the idea of artistic lighting for the small or modest garden. He has designed little houses for the luminaires which by day appear to be bird houses mounted atop or hung from rustic poles, trellises, and other garden architecture. At night they shed light on flowers, trees, the bird bath, or fountain. A few of his numerous attractive designs are shown in an accompanying illustration.

Cold and Hot

THE sun shines hottest on high mountain tops where explorers shiver with the intense cold.

Observations of solar radiation from the summit of Mount Aunconquilcha, Chile—nearly four miles above sea level—where its intensity is nearly one sixth again as great, have just been reported to the Smithsonian Institution. Delicate radiation-measuring devices were carried to this crest in the highest Andes by C. P. Butler.

The instrument used in the measurements was set up on a cake of ice. Although, of course, the result was to be expected, it seemed a little incongruous to be suffering from the cold and at the same time measuring solar intensity far greater than that which would have been recorded in the hot desert far below.

"The results of the instrumental data," says Butler, "were not apparent to the senses. At the mine (a sulfur mine on the mountain top) even during the middle of the day the temperature hardly rose above freezing, even though Aunconquilcha is nearly 200 miles north of the Tropic of Capricon toward the Equator. We all wore heavy clothing, stocking caps, mittens, and heavy shoes. Despite the cold, one burned severely in a few hours unless protected by a sunshade. The men who worked in the mine were burned almost black. Although the data show that the amount of solar radiation here is greater than ever experienced at sea level, the only way this could be felt was in a feverish feeling about the nose, cheeks, and neck."

Storm-Testing Concrete

ROARING wind and drenching rainstorms are produced artificially by research engineers of the Portland Cement Association to test weather-tightness of concrete masonry walls. Wind tunnels equipped with a series of water jets are part of the apparatus in their field experimental laboratory at Elmhurst, Illinois.

Water in a volume equivalent to 2½ inches of rainfall per hour is driven against the test walls at a wind velocity of 25 miles per hour. The wind is produced by an airplane type propeller moving at 1750 revolutions per minute. This wind speed is more than twice the average wind velocity of 11 miles per hour recorded by the United States Weather Bureau even in the "Windy City" of Chicago.

The test walls are wired with electrodes. When current at known intensity is passed between pairs of these electrodes, any change in resistance due to penetration of moisture is shown by a delicate electric meter. Forty-seven walls, of different types of concrete masonry units, are included in the series of tests now under way.

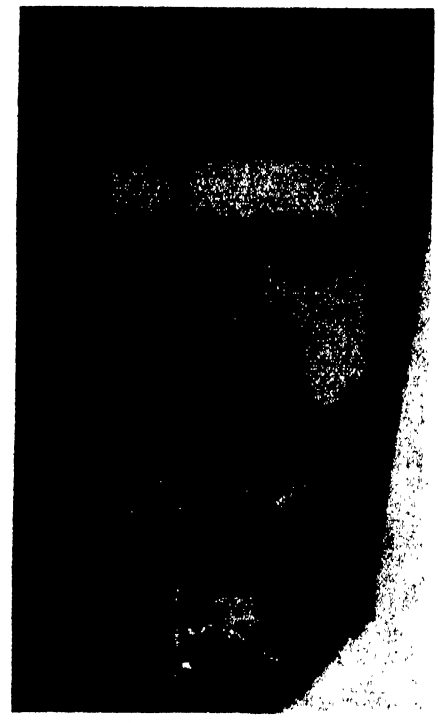
According to R. E. Copeland, engineer in charge of the tests, all of the walls are given many times more severe exposure to wind driven rain than they would undergo in years of actual service. "Only under hurricane conditions, for very short periods, would walls ever be subjected to such rigorous treatment.

"The testing methods are planned, and the apparatus so designed," Mr. Copeland explains, "that the results can be translated directly into terms of the performance of walls in actual service. Water-tight walls have long been a problem common to all types of masonry construction. No tests with any structural material have been previously reported in which natural conditions have been so closely imitated."

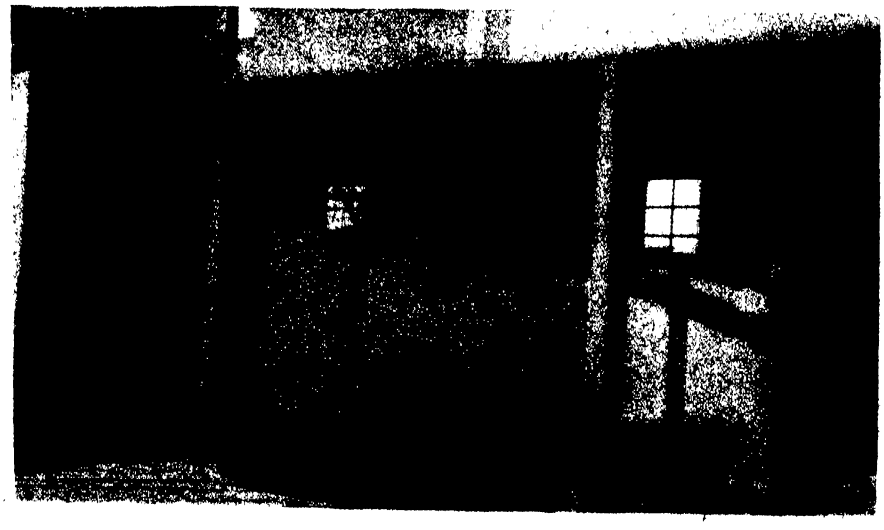
Platinum Flute—Best in World

THE phrases "golden" and "silvery tones" have long been stock descriptions used by poets and critics to describe beauty in music. Now, it appears, science and art have co-operated to add a new term to the musical writer's dictionary—"platinum tones."

Such, at any rate, is one of the possible results of the introduction by George Bar-



***Above:* Propeller and water sprays used for testing concrete. *Below:* Exterior of the wind tunnel with section of a wall under test at the left**



rere, world famous flutist, of a solid platinum flute. Made at a cost of 3000 dollars, this instrument is said by musicians and scientists who have heard it to possess tonal qualities superior to those of any other flute ever made.

The discovery of the qualities of the flute was not an accident nor was its construction prompted by vanity, according to Mr. Barrere. Science had arrived at theories which indicated that platinum was the ideal material for the instrument. Therefore, just as a violinist seeks a Stradivarius violin when he reaches the top of his profession, Mr. Barrere, who had previously owned a gold flute, turned to platinum.

The theory to which Mr. Barrere referred was developed by Professor Dayton C. Miller, an expert on tonal dynamics and also a flutist, at the Case School of Applied Science, Cleveland, Ohio. Professor Miller, after numerous experiments with flutes of various materials, declared that the denser the material used in the instrument, the better the tone produced. He rated gold the best material he tested, but suggested that, since platinum is even denser than gold, it should be better still.

Actual tests made of the tones of gold, silver, and platinum flutes at the Bell Telephone Laboratories in New York tended to substantiate the theory.

RUST

ONE billion dollars is our average yearly loss due to rust, it is estimated by Dr. R. M. Burns of the Bell Telephone Laboratories. This equals the interest on the public debt of the United States.

RHYTHM LESSENS FATIGUE

WHEN soldiers are marching to the rhythm of band music, less fatigue is felt than when they are merely walking along without cadence, says Dean F. W. Shumard of the National School of Time Study, Norwalk, Connecticut. Laborers who sing or chant during their working movements, he continues, are not always manifesting the feeling of pleasure in their endeavors, but they are creating a rhythm for their movements which makes their work easier.

One reason for the efficacy of this rhythm in lessening fatigue is that it keeps the worker's mind away from the contemplation of his tiredness. Everyone knows from experience that a person not conscious of his growing fatigue is less tired at the end of the day than one whose introspection constantly centers on the likely effects of the work. Therefore, points out Dean Shumard, one of the chief aims of time study as applied to industry is to make the manual operations of each worker as regular and rhythmic as possible. Even if a slight slowing-down of a particular operation is necessary in order to secure rhythm, the day's production is increased through the steady pace that the workman maintains.

Rapidity of motion is not necessarily more energy-consuming than slowness of movement. Usually those operations which lend themselves to rapid movements are of the light type of work, and the worker can

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G-E research has saved the public from ten to one hundred dollars for every dollar it has earned for General Electric.

GENERAL ELECTRIC

THE IDENTITY THEORY

THE author claims to have discovered a new theory opposed to that of Relativity. The fundamental postulate of his theory is that Space and Time are identical entities, differing only in the number of dimensions into which they are divided. He points out that the constancy of the velocity of light follows directly from this fundamental postulate, whereas in the Relativity Theory the fundamental postulate of a space-time continuum does not, of itself, lead to such a conclusion. It is then shown that the electro-magnetic field equations comply with the identity postulate and finally that the gravity field is indirectly explained by it, thus covering all field phenomena. A considerable part of the text is free from mathematics.

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quickly set a rhythmic pace for himself, thus saving considerable fatigue. On the other hand, slow tasks are often of the heavy type wherein rhythmic movements are nearly impossible, and therefore these slow tasks are much more tiring than the faster but lighter ones. The matter of rhythm plays an important part in the work of the time-study engineer.

Dry Ice as Rat Killer

HARDLY a month goes by without someone discovering a new use for solid carbon-dioxide. One of the latest additions records the effectiveness of dry ice as a rat-killer. Although non-poisonous, the gas from a chunk of dry ice as large as the rat hole will accommodate, will neatly suffocate the rodents as they sleep, provided all holes are stopped up after inserting the solid gas. In order to catch 'em while they sleep, the treatment should be applied in the morning. —*A. E. R.*

Haze Meter for Forest Fire Lookouts

ANNOUNCEMENT has been made by the Pacific Northwest Forest Experiment Station of the Forest Service, United States Department of Agriculture, of a new instrument called the Byram haze meter. Because of the important rôle which visibility conditions play in the detection of forest fires, the discovery of a simple and accurate means to measure the effect of haze on the distance fires can be seen marks a real advance. This instrument is used by forest fire lookouts to determine the distance at which they can see a wisp of smoke from one of the incipient forest fires for which they are ever on the watch. It will no longer be necessary to rely on makeshift estimates and guesses on taking action to meet changing conditions. In clear weather one lookout can keep watch over a wide territory, but when the air becomes filled with haze it is necessary to man more points in order to cover the same ground, thereby adding to the cost and difficulty of providing adequate protection.

The haze meter is based on the discovery that a smoke column is just barely visible to lookouts with good eyesight against a background about 60 percent as bright as the sky at the horizon. It provides a mechanical means for finding a point on the background or landscape that is 60 percent as bright as the horizon. By sighting through an arrangement of filters and bringing up by means of one stationary and one movable mirror first one and then another part of the landscape, the observer is able to find some ridge or other recognizable point that is just 60 percent as bright as the sky at the horizon. The distance to that part of the landscape is scaled off on the map and becomes the visibility distance or the maximum distance that he can expect to detect a smoke column of a certain size in that direction at that particular time.

Foresters will use the haze meter to measure haze in terms of the visibility distance of small smokes in order to deploy their fire lookouts on towers and peaks so as to meet current changes in atmospheric conditions. However, since the haze meter is based on fundamental principles it is thought that others may find use for the instrument to measure the optical density

of the atmosphere. This can be done in several ways, the simplest being to consider the measurements of visibility distance to the standard size of smoke column for which the instrument is calibrated as indicating the relative quantity of haze present.

Improved Silver Plating

A NON-TARNISHING silver plate has been developed by chemists of Washington University. The secret that spells bad news to the manufacturer of silver polish but relief to the lady of the house who likes to keep her silver bright, is the incorporation of tin into the silver during plating. A silver-tin alloy containing 20 to 40 percent silver produces a plate that has the appearance of pure silver, takes a high polish, and wears better than conventional silver plate. —*A. E. B.*

Photographing Burned Documents

BY making written or printed words on burned documents easily read, a new application of the process of taking photographs by infra-red instead of by visible light places a powerful new weapon in the hands of the law in its fight on crime, and supplies new evidence in settling disputes arising from the burning of essential papers, according to Gustavus J. Esselen, Boston chemical consultant.

Ashes of written or printed papers reveal essential facts when photographed by infra-

Above: **A charred note photographed by ordinary white light—undecipherable.** ***Below:*** **The note is revealed by photography with infra-red rays**

red rays invisible to the human eye, Dr. Esselen said, for although the whole document appears black in visible light, in infra-red rays (or the so-called "black light") the tiny residue left of the ink has a different "color" from the ash of the paper.

"While the reading of charred documents is spectacular and important," said Dr. Esselen, "the same technique reveals important facts about unburned documents without injuring them. Alterations invisible in ordinary light often are clearly revealed by infra-red. Differences in reflective power for visible light give us our sensation of color but similar differences in reflective power exist both in infra-red and ultra-violet regions of the spectrum. Two ink marks that are equally black in visible light may be totally different in infra-red because their reflective powers are different. Forgers who change documents and use an ink different from the original can be caught by infra-red photography if the inks are different enough. The same is true of ultra-violet. Neither infra-red nor ultra-violet alone will detect all such alterations but between the two the forger has a much narrower margin of safety. Differences in papers as well as inks are detectable by these means to establish the authenticity of questioned documents.

"No method except this new photographic process is known for making infra-red visible. Ultra-violet causes certain materials to fluoresce and thus its effects are made visible. No corresponding effect of infra-red has yet been discovered."

Our Calendar About Three Hours in Error

WHEN Pope Gregory XIII reformed the calendar in 1582, with the advice of the astronomer Christopher Clavius, he corrected an error that had existed in the earlier Julian calendar of nearly 10 minutes a year, but even his calendar is not perfect. The average length of the year according to the Gregorian calendar is about 24 seconds longer than it should be—the time that the earth takes for a complete trip in its orbit around the sun. But this remaining error is so small that it will not be until about the year 4600 that our calendar will be as much as a day in error. At present the difference that has accumulated since Pope Gregory's time is only about three hours—not enough to bother anyone.

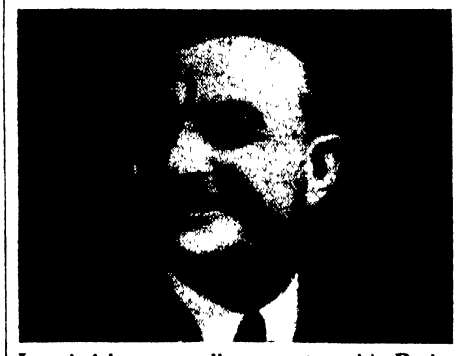
The whole difficulty in making a satisfactory calendar comes from the fact that the earth does not turn an even number of times while it is making a trip around the sun. Instead, it turns almost 365¼ times. More accurately the number can be expressed as 365.24219, but even that is not exact. The two periods of time are incommensurable—one cannot be expressed precisely in terms of the other, no matter how many figures are used after the decimal point. Consequently, the best calendar is the one that most closely approximates this relation.

The Julian calendar, named after Julius Caesar, by whose decree it was introduced in 45 B.C., was due to the Roman astronomer Sosigines, who had placed the length of the year at 365¼ days. As the extra fraction of a day amounted to one day every four years, the leap year was invented. By having a 366-day year every fourth year, the difference was mostly accounted for. But because the actual year is about 10 minutes shorter than Sosigines assumed, by 1582 the calendar was 13 days out of step, and the beginning of spring came on March 12, instead of March 25, where Caesar had placed it. If this had been allowed to continue, it would eventually have come in the middle of winter, and as this would have put Easter and other religious festivals in the wrong time of year, Pope Gregory ordered the reform that bears his name.

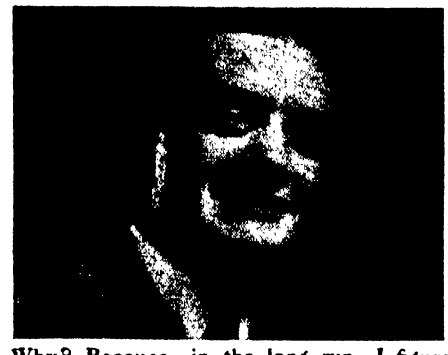
Instead of restoring the beginning of spring to the 25th, however, he made it the same as in the year 325 A.D., the date of the Council of Nicaea, which had set the rules for determining the date of Easter. Ten days were dropped bodily from the calendar, which made the necessary correction. Then, in order to prevent a recurrence of the error, he ordered that, in the future, years marking the beginning of a century should not be leap years unless they were divisible by 400.

"Why I Switched to Dodge"

by GEORGE DeWITT SHEETS, Cranford, N. J.



I traded in my small car to get a big Dodge "Beauty Winner." It was one of the best moves I ever made.



Why? Because, in the long run, I figure this big Dodge is actually going to cost me less than the small car I had.

For example, I'm getting 21 miles per gallon of gasoline—and I haven't added any oil between changes. And Dodge is so easy to buy! One can get a Dodge for not much more than $25 per month! It's easy to see why more people buy Dodge cars than any other make, with the exception of the three lowest-priced cars!

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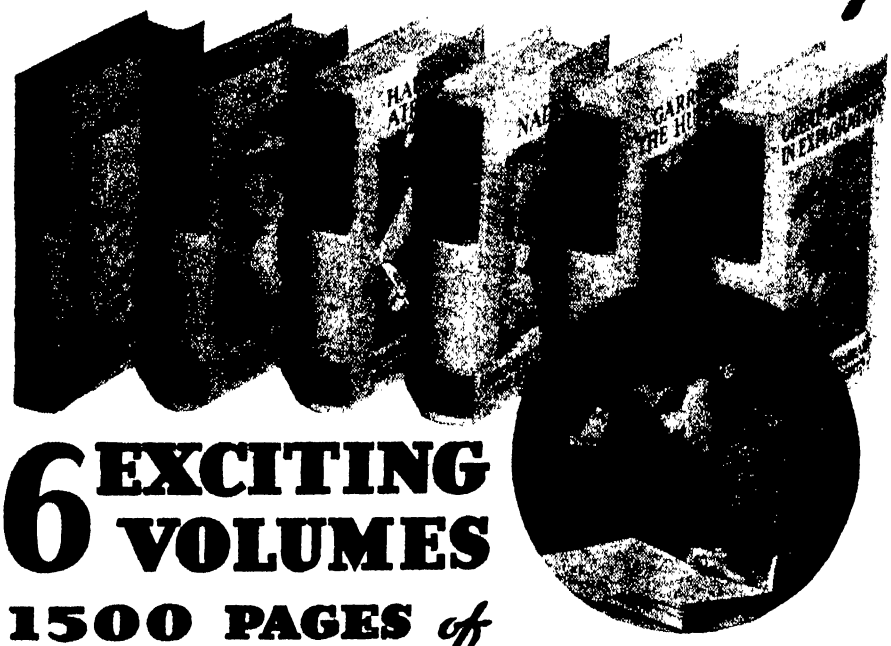

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S.A.-6-36

Other years would have the extra day if their number was divisible by four. Thus, in the Gregorian calendar there are 97 leap years every four centuries, instead of a hundred, as Caesar had it. For this reason, the year 1900 was not a leap year, but 2000 will be one.

But this difference of three days every 400 years is a little too much of a correction, by about 24 seconds a year. This amounts to a day in 3000 years, so by the year 4600, spring will start on March 22, unless some other change is made in the meantime. By that time the Eastern Orthodox Church will have a more accurate calendar than ours. They adhered to the Julian calendar until 1923. Then they adopted the Gregorian but with a slightly different leap year rule. This is that century years shall be leap years only when their numbers divided by nine give a remainder of two or six. This will not be out of step with ours until the year 2800 which, in the Gregorian calendar, will be a leap year, but in the Eastern reckoning it will be an ordinary one.—Copyright 1936, *Science Service.*

AIR CONDITIONING

MORE than 6000 air conditioned railway cars are now in use, and about 1000 more are under order.

Spinach Loses Standing as Health Food

GOOD news for spinach-haters! The leafy vegetable, obnoxious to many and unwillingly eaten because of widely-heralded health value, is losing its high standing. Spinach has been considered a valuable food because it has a high content of blood-and-bone-building iron and calcium. Less than half of the iron content of spinach, however, and less than a third of its calcium are in a form that can be used by the body, it appears from a report by Drs. M. K. Horwitt and C. R. Cowgill of research made by them at Yale University with the late Prof. L. B. Mendel.

Similarly, the amount of protein available for human nutrition is not what would be thought from the amount found in spinach by chemical analysis.

In their research, the Yale investigators devised a method which in the future can be used for determining in other foods besides spinach the amount of nourishing substances actually available to the body, as compared with the amount theoretically available as judged by the total content of these substances found in foods by chemical analysis.—*Science Service.*

Sandy Soil Solidified by Injection of Chemicals

TURNING porous sandy soil into solid rock-like material with the texture of medium hard sandstone is the latest technique by which European chemists are now strengthening subway tunnels, improving hazardous foundations of buildings, plugging leaks in the beds of streams of valuable mineral springs, and restoring underwater dams.

The system, known as the Joosten process of soil solidification, consists of injecting

into the soil two chemical solutions which combine to form a gel-like material. The gel material has a high surface tension and acts to draw the sand particles closely together. Loads of 1100 pounds to the square inch are successfully withstood by the artificially solidified sandy soil.

Applications of the new method are many. The Cathedral Church of Ribe in Jutland rested on closely packed chunks of rock lying on a bed of fine sand. In the course of years and due in part to increasing nearby motor truck traffic, the foundations subsided and cracks appeared in the masonry. Underpinning the walls with girders was deemed inadequate. It was decided to widen the foundation by means of chemical solidification in the underlying sand layer. The operation was so successful that the menace to the cathedral structure no longer exists.

In connection with recent construction on London's subway system the method was also tried successfully. Injection pipes for the chemicals were driven through the planking used to line the finished part of the tunnel. A chemically solidified arch of smooth gravel was formed in the tunnel's roof. When it came time to cut away parts of the roof which projected into the tunnel profile, pneumatic chisels had to be used because of the strength of the material.

The two solidifying chemicals are reported to be silicic acid, which is put into the sandy soil first, and an unnamed salt solution that immediately reacts with the silicic acid to form an insoluble colloidal silicic acid gel. For successful operation, a careful study must be made of the soil type and use confined to sandy layers. The technique will not work for clay or mud.

The process may find usefulness in the movement for improvement of the secondary, "farm-to-market" roads of the United States, officials of the Highway Research Board here indicated when they were told of the German experiments.—Copyright, *Science Service*.

Encourage New Uses for Cotton in Highway Construction

SECRETARY of Agriculture Henry A. Wallace, has approved the use of funds for the purpose of stimulating field tests of new uses of cotton in highway construction. The project provides for the diversion of manufactured cotton fabric for use as a reinforcement membrane in bituminous surface treated highways and for cotton mats for use in curing concrete highways. These materials will be furnished upon request to state highway departments so that they may be tested in widespread use under all climatic conditions. If the results of these tests are as favorable as certain preliminary trials along these lines have indicated, these new fields of use would require large quantities of cotton in the future.

Eggs Stay Fresh if Dipped in Oil

MANY poultrymen beat the heat in summer by dipping eggs in a thin, white mineral oil. This seals the pores of the shell and helps the egg retain its fresh quality.

Recent tests by the United States Department of Agriculture show that oiled

(*Please turn to page* 352)

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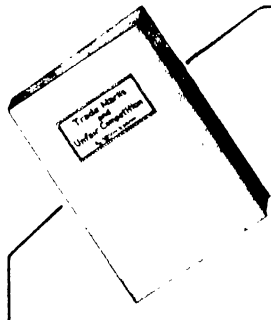

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THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

RIGIDITY and then more rigidity in the design of telescope mountings is a quality which Russell W. Porter strongly stresses in the latest (fourth) edition of "Amateur Telescope Making," and your scribe now keeps a weather eye peeled for really rigid mountings having good heavy cross-sections in the right places. A mounting known as the "Hempstead Hydrant," and shown in several accompanying illustrations, makes an excellent impression in this regard, and

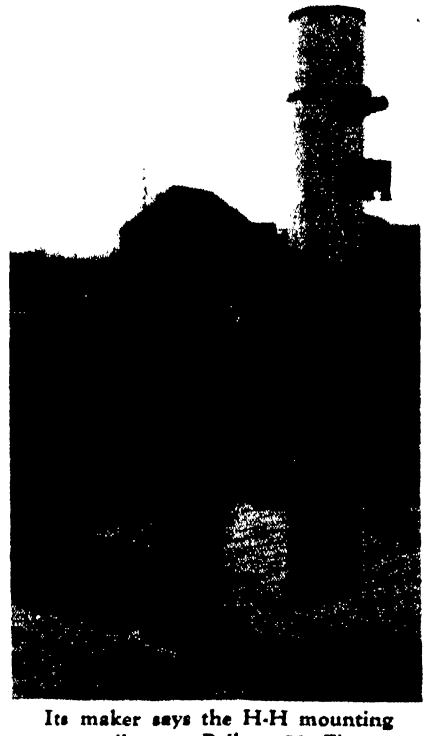
The main works of the Hydrant

in other ways as well. At the place which Porter calls the "bottleneck" ("A. T. M.," page 130) its declination axis has a diameter of 3". We have asked the maker of this telescope, E. B. McCartney, proprietor of the Long Island Toro Co., golf course and lawn equipment, 76 Roslyn Road., Mineola, N. Y., to describe it, and this is what he writes.

"The mounting is of the Everest 'Town Pump' type, described in Scientific American, May 1935. I saw the 'Town Pump' when it was shown at *Stellafane*, and copied a good many features of it, although mine starts with a rear axle differential carrier for a polar axis. This automobile part is ideal for the purpose, as it has two axes at right angles and the declination axis can be large. Only a few makes of cars have suitable carriers, as most of them have oval or square rims, and some have the pinion shaft out of center with respect to the rim. I wonder that this auto part hasn't cropped up before as a mounting, but I know of only one other—Leuchinger's. [A. R. Leuchinger, Wantagh, N. Y. —*Ed.*] The old Chevrolet carriers are dandies for the purpose and can be had in any auto graveyard. This Chevrolet carrier is riveted to a torque tube, and Porter could make an elegant mounting design by running this tube through bearings in a concrete pier and dispensing with the rollers under the rim. This would make a simple mounting for those who are not equipped to do considerable machine work.

The Hempstead Hydrant with phonograph drive, on 5" pipe pedestal

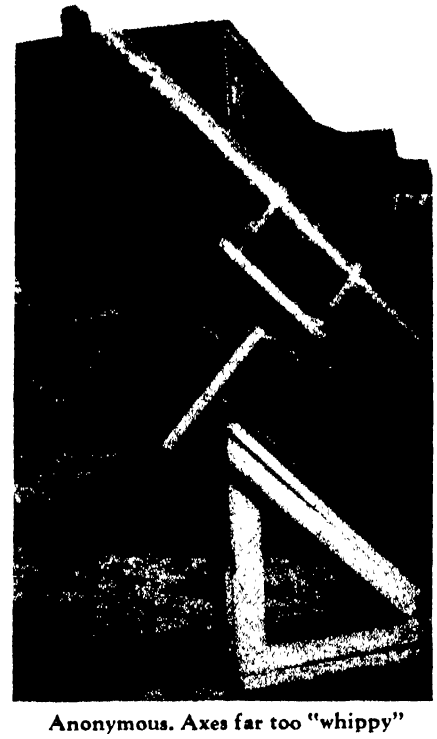
"The telescope, a 6", has an octagonal tube of wood, $\frac{3}{8}$" thick, which rotates in rings made of brass channels rolled circular. It has a phonograph motor drive [This part will be described in the 'A. T. M. Supplement,'—or 'A. T. M.' Vol. II, as it may now be called—some time later.—*Ed.*] No vibration from the motor is apparent, even when using a magnification of 425 diameters, and the motor can be wound without disturbing the field of view of a $\frac{1}{2}$" eyepiece. I paid a dollar for the differential carrier and, excepting eyepiece and finder, the whole telescope cost about 25 dollars. In general, the mounting is about the same size as Everest's, with still larger bottleneck. The declination axis could be shortened 2 or 3 inches to make it more compact. The counterweight rod slides into the hollow declination axis."



Its maker says the H-H mounting owes tribute to Bell, p. 51, Fig. 35

McCartney concludes, "Yours for bigger and better bottlenecks," and he is right—we are for them. So let's hope that more "Town Pump" and "Hempstead Hydrant" mountings will be created, in the interests of solidity.

While McCartney's bottleneck with 3" diameter, isn't quite so chunky as the real bullneck shown in Porter's drawing in "A. T. M.," few are equipped to go literally quite that far, though it would be desirable. Someone thought Porter's other sketch—the right hand one in Figure 2, page 131, "A. T. M.,"—was perhaps a caricature and a bit skinnier than any that have actually been made, so we reproduce a photograph



Anonymous. Axes far too "whippy"

of one that is mounted on real "pipe stems" of the kind that Ellison in a letter we published some time ago, called "whippy."

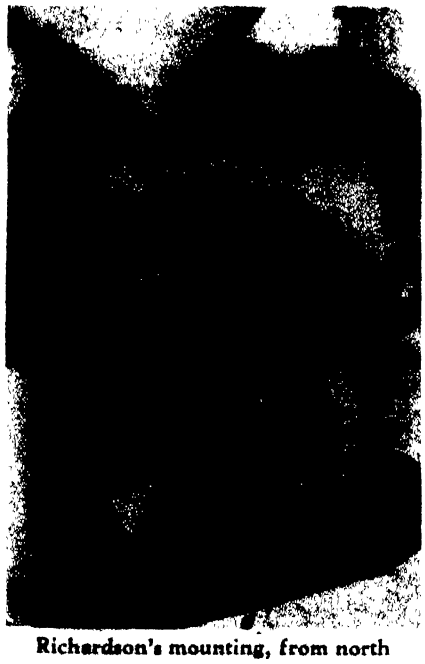
ANOTHER solid mounting of the "Town Pump" type is shown on the opposite page. E. R. Richardson, San Gabriel, California, is the maker and the telescope is a 12½" Pyrex (looks as if this one were almost the thirteenth member of the "Twelve Inch Club,"—but it turned up after that page had already been made up). "This mounting is built around a 14", 120-pound fly wheel which I salvaged from the scrap pile of a local foundry," the owner writes. "The axes are from an auto wrecking yard—truck rear axles 2" diameter and of finest steel, and the rollers are truck ball bearings with double rows of balls.

Richardson's massive polar axis

The moving parts weigh over 400 pounds, yet there is very little friction and a 1/25 H.P. synchronous motor drives it."

It begins to look as though Porter's heavy emphasis on mass in the design of telescope mountings were bearing fruit.

In his most recent letter Ellison again reverts to "whippy" mountings—the term, an apt one, was in an earlier letter of his which was published here: "Just a remark on whippy mounts and slide-off observatories. The run-off roof—or run-off shed—is doubtless the easiest to construct. But when you come to work with it, you may well regret that you took the easiest way. The advantages of the revolving roof are that it keeps off (a) wind, and (b) radiation. Even the most rigid mount will vibrate in a breeze, and as for a whippy one, the images execute such a war dance that observation is hopeless. And, if your telescope tube is of sheet metal, as it is three times out of four, you will find the images play the most extraordinary pranks. Often they are like hairy caterpillars. On a clear night, especially if windless, the upper side of



Richardson's mounting, from north

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the tube gets cooled by radiation, probably several degrees below the lower, and the upper half of the mirror gets cooled below the lower half. Well, anyone who knows mirrors and their little ways can tell you what that will mean. The remedy is either a wooden tube, or a roof over the instrument. No amount of swathing in felt and so on, will mend matters."

From this subject Ellison shifts to beeswax, and gives us the history of its recommendation in his treatise in "A.T.M.," along with the "Swedish pitch" ("A.T.M.," p. 75) which no Yankee has ever been able to find; telling how, in his own mirror making, the two of them have now given way to coal tar pitch, as is also happening in the U. S. A.

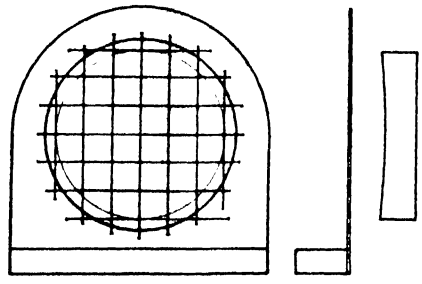


FIG. 1
The Sholes grid for locating 'em

"About that coal tar pitch. The whole trouble began with the old masters of the art in the seventies and eighties of the last century. These old fellows, like all their Victorian generation, were saturated in pedantry, and gave whole pages of directions which I gradually found to be so much 'bunkum,' and scrapped bit by bit. One of these directions was that the pitch must be only the best, and the best meant Swedish pitch. Now Swedish pitch is vile stuff, is full of dirt, and has to be strained; also is desperately sticky. It was in trying to devise some way of mitigating its stickiness that I adopted the plan of mixing in a percentage of beeswax.

"But one time I was in a benighted place where Swedish pitch could not be obtained, and had to put up with what I could get, which was coal tar pitch. And, to my surprise, the stuff figured far better and more certainly than the Swedish. I sometimes mix resin with it. That is good stuff too, but needs a lot of softening with turps."

Ellison then comments on the HCF lap: "I gave the HCF dodge a good try-out, and I find as Everest does. It is unnecessarily complicated for figuring, but for quick polishing it is the goods. I merely pour the hot pitch on the glass tool as usual, but immediately lay a sheet of HCF on it, and press the mirror on, previously covered with a paint of rouge and water. [See A.T.M., p. 367.—*Ed.*] The heat of the pitch softens the HCF, and it takes the curve very completely. The sheet of HCF need not be the full size of the tool, as it flows under pressure, and spreads to 25 percent or more wider than it was. After this I cut out facets just as usual, only the HCF plus pitch is far easier to cut than plain pitch. This too is fine for polishing. When it comes to parabolizing I make an ordinary tool of the coal-tar stuff."

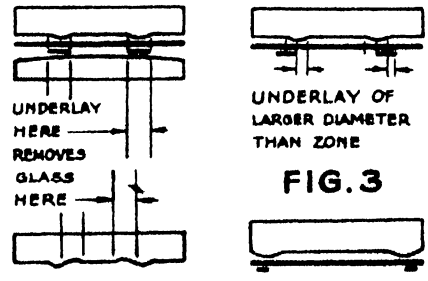
Never having observed HCF flow or spread under pressure Ellison's mention of a 25 percent spread causes one to wonder whether Irish HCF and the Yank variety are quite the same thing. They might differ.

Ellison next comments on the rubber "Door Mat" for tired lap makers: "The very latest stunt seems to be casting the tool by means of a rubber honeycomb mat made expressly for the purpose. I have no doubt that it will work; also that it will be a godsend to many. But I can tell you a story of the same idea, which I tried out in 1890, in collaboration with a friend and former pupil, Dr. Nathaniel H. Alcock; one time Professor of Physiology in McGill University, Montreal. We made a sort of honeycomb mould by cutting out 1" squares in a sheet of plywood. The cutting was done with a fret saw, and the thing when finished was just like the rubber mold, except that it was not pliable. The squares were smoothed with a sharp knife to an angle of 45° inside, and the whole thing dipped in water, and laid on a wet surface. The pitch was ladled into the squares with a teaspoon, and when hard was pushed out, and each facet cemented to the face of the glass tool by holding the back of the pitch square to a flame for an instant. When all the squares were in place, the tool was held in a basin of hot water till soft, and the facets moulded into contact, by pressing the mirror on in the usual way. The method had the advantage that, if any facet were damaged or detached, it was easy to make and attach a new one. I soon got tired of the tedious job, and found my own way did all that was required, and did it in far shorter time."

This resembles the method described a little later by Ritchey. Everest no longer spoons the pitch into the "Door Mat," but pours a regulation lap and then pushes the "Door Mat" down into it by means of the mirror, using plenty of warm soap-suds.

MAKING his own drawings, which are reproduced here, Raymond A. Sholes, 10004 Regent St., Los Angeles, California, describes a bit of his technique, as follows:

"In the February number, Nicholas M. Smith's method of testing was described; also Ellsworth L. Martinelli's technique for using HCF. The success of both depends upon knowing the diameter, or radius of zones, which must be measured while the eye is at the knife-edge. Both Everest's and Mason's methods of measuring are O.K., but I hit upon the idea shown in Figure 1 of the accompanying drawing, which has the advantage that it allows the operator to view the whole mirror and yet measure any zone as accurately as is necessary.



Details of the Sholes technique

"A piece of stiff cardboard was marked off in 1" squares, and a hole cut in it, somewhat larger than the mirror, the center of the hole being located where two of the lines cross. Silk threads were strung across the opening both ways, located on the pen-

cil marks. The card was tacked to a block of wood and stood in front of the mirror, as shown, while testing. It must be so located that the center cross is directly in line with the center of the mirror. The threads make black lines where the mirror is light, and bright lines over the dark areas. These do not interfere with viewing the shadows as shadows, but are always there to refer to when wanted.

"The crests can be measured and checked both on the vertical centerline where the shadows reverse and on the horizontal centerline where one would normally place a mask. Checking one against the other leads to greater accuracy. For a large mirror, the cardboard would have to be replaced by a piece of plywood or a wooden frame.

"While using underlays and HCF, as described by Mr. Martinelli, my experience was that the work done on the glass is always a little toward the center from the underlay. A typical set-up is shown in the upper part of Figure 2. The lower part shows the result—a depressed zone just inside the raised zone that was being attacked. I found that, if the inner diameter of the underlay is made the same as the highest part of the zone, and the outer diameter a little larger than the zone diameter, as shown in Figure 3, there was no tendency to create new zones. Even when a raised zone was near the edge, the underlay, as shown in Figure 4, brought it down—believe it or not—without causing a turned down edge."

STELLAFANE convention this year, Saturday, August 8. Porter probably coming.

WE learn that the 41¾" x 6½" Saint-Gobain low-expansion glass flat, also the machine, with which Ritchey made the 40" Ritchey-Chrètien a year or so ago, are lying idle in Washington. If some amateur club would pick up these items an interesting club project of some sort might be worked out.

IF you feel you need more materials, in order to swing the telescope making hobby, listen to this, from Bre'r Fred Ferson of Biloxi, Mississippi—just one of us TNs. "I am going to start the Ferson Plan for the redistribution of telescope materials, and call it 'The Share the Wealth of Telescope Materials'. Every man who joins, by paying Ingalls and Ferson six bits, might receive one brick building, 20' x 100' with tower and dome, one large and one small lathe, a milling machine, drill press, shaper, planer, a forge, optical spindle, grinding machine and motor, and small tools and sundries too numerous to mention. Also one Pyrex disk, and tool per month—prism blanks, rouge, pitch and 'Door Mat'. Last but not least, $200 per month per TN."

To this great plan for spending our way into vast wealth Ingalls adds a compromise arrangement by which the work is to be divided between Ferson and himself. Ferson is to provide the materials and Ingalls will get the six bit dues. All of the benefactors must agree to drop and break the mirrors before the last day of each month, thus adding to the wealth of the community by making the remainder of its members work that much harder, as well as "putting money into circulation." Local organizers' salaries will be limited to nominal sums—say $12,000.

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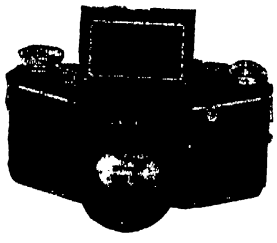

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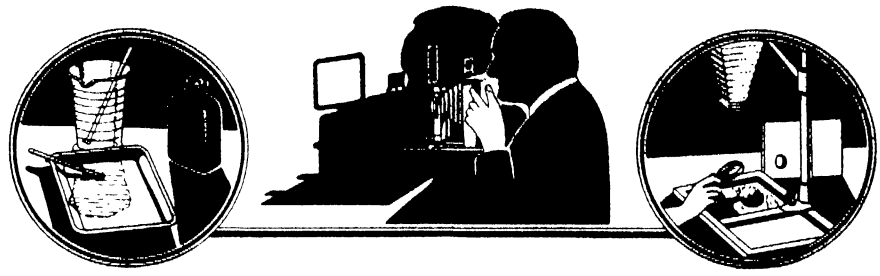

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Hobby Photography

ALMOST any hobby can be doubled in interest if seen through photographic eyes, even though photography itself be your particular avocation. Whether you lean toward stamp or coin collecting, woodworking or model boat building, or some such activity as fishing or hunting or "collecting" bird and animal tracks, you will find camera opportunities galore. The objective attitude which you will assume in photographing the various phases of your hobby will develop a sort of romantic feeling about the hobby that will do wonders in helping you over

The Model Builder

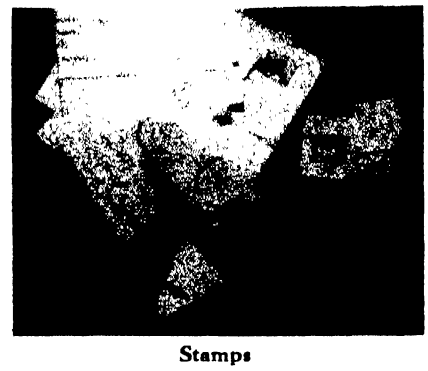
some of the obstacles which now and then you meet in trying to work out some particularly tough problem.

Generally speaking, a camera equipped for ground glass focusing is best for hobby photography, although any camera can be made to do for most of the pictures you will want to make. On a ground glass one can compose carefully, focus accurately in order to get sharpness over the entire area or to limit definition to the subject matter alone, which in certain instances, as when it is desired to subordinate the background, is a considerable advantage from the pictorial point of view. A tripod or other firm support is necessary for almost all ground glass work. Filters will also be required in certain instances where contrast cannot otherwise be achieved.

Hobby pictures may be divided into two categories—the record type and the pictorial. One of the chief uses for the former would be for chronicling the step-by-step history of a particular project, the story of a fishing trip, pictures of specimens for the collector of eggs, stamps, or whatnot. In this connection, the collector can use photography to obtain pictures of objects he does not possess and for one reason and another, usually financial, he cannot afford to purchase. Thus, he can take a picture of some desired object that catches his attention in a store window or in the collection of a fellow-hobbyist. The result is not the same as actually owning the item himself, but is certainly a good second-best.

The pictorial phase of hobby photography would include shots having an atmospheric quality about them. Some record pictures lend themselves to this treatment, but usually it will involve a special arrangement of subject-matter to achieve a generalized impression of certain phases of your hobby or something epitomizing the hobby as a whole. Such a picture can be enlarged and displayed in some appropriate manner in one's den or in some other part of the home.

Composition is important whether the picture is a record or imaginative impression. There is no reason why a record picture, merely because it is utilitarian, should not be as well arranged as an artistic one. An attractive and careful disposition of the various components of the picture will make each photograph not only pleasant to look



Stamps

at but in many instances will give a better idea of the subject-matter photographed.

Hobby photography will sometimes involve having someone's hands in the picture and this can, of course, best be done by having a friend release the shutter while your hands are busily engaged within the picture area—or the other way about. When you are alone, as will probably be the case in many instances, a delayed exposure device, which may be attached to any camera having a cable release, can be relied upon to do about the same service. While this is not feasible with the fishing hobby, for ex-

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ample, your companion, if he is not too absorbed himself and if he also be of a photographic turn of mind, can be pressed into service. In this field, incidentally, some interesting pictorial shots can be made of the fishing paraphernalia, your companion silhouetted against a lowering sky, or the boat on the shore when the light is particularly attractive.

A pictorial diary or album can be made of the record type of pictures that can be used for reference or display to friends. Individual pictures may be filed in a box reserved for the purpose and properly indexed so as to be easily accessible when needed.

Picture your hobby. In time you will find the results invaluable not only to yourself but to other hobbyists as well.

Photographic Nightmare

ORDINARILY, a cigarette is a fairly harmless creature. It has elegance, a certain beauty and grace, is pleasant to handle, and comes as something of a benefactor in times of stress. All these things the writer appreciates and when recently the assignment was handed him to do the apparently simple thing of photographing a row of cigarettes to fit in with a certain definite layout, he fairly beamed. Agreeable jobs like this came one's way very seldom, he thought.

The specifications were that the cigarettes had to stand on end, that they were to be varied in type, cork-tipped and plain, round and flat, that shadows were to be long and clearly defined in the photograph and that the cigarette in the immediate foreground was to be taller, much taller, than the last one at the extreme end. Also, the background had to be plain and unobtrusive and the general quality of the finished product was to be pictorial.

Next to the purchase of the required cigarettes, the easiest part of the undertaking was to stand the cigarettes on end. This was accomplished by pushing thumb tacks into a card at a uniform distance apart and placing a cigarette on each point. So far, so good. From then on the troubles never ceased. For the shadows a spotlight was obviously needed. When general lighting also was introduced in order to show up the front part of the cigarettes more clearly, the shadows seemed to suffer somewhat and more detail got into the picture than was wanted. Also, something had to be done about the background, and it seemed that the only way to get an even tone was to shoot down for an angle picture. But this would not do. The horizontal arrangement that was wanted was not to be had in this way, even though the first cigarettes did look larger than the ones farthest from the camera.

An arrangement of 40 cigarettes was tried first but without success, then 70 and still no luck. Laboring under the strange notion that the solution lay in numbers, the writer drafted 50 more and lined up his 120 "men" for the final dash to a victory that, alas, still proved elusive.

The evening ran on and crept into the morning, when the idea occurred to the harassed photographer that perhaps, after all, he had too many cigarettes, too much light, too much of an angle, too much cardboard—in short, too much of everything. So down came the surpluses, one after another. The 120 cigarettes were reduced to 24 in a single row, the general light was shut off, leaving only the spotlight, the angle was eliminated and foreshortening resorted to by having the camera lens on a dead level with the cigarettes, giving a giant of a cigarette in the immediate foreground and a third this size to the last cigarette. The cigarettes were arranged in a row along an edge of the cardboard by the thumb-tack procedure, the spotlight lowered to give a long shadow almost twice the length of each cigarette and the cardboard so adjusted that a black curtain served as a background.

Cigarettes and Shadows

The result, which finally gave satisfaction all around, was a row of cigarettes against a void, giving, with the long shadows cast by the cigarettes, a rectangular composition.

The aftermath, for the photographer, was the photographic nightmare impression shown in the illustration.

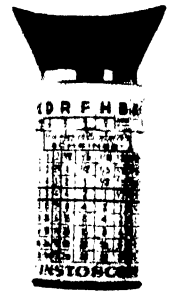
(The final satisfactory cigarette picture appears on page 310 of this issue.—*Editor.*)

Camera Hunting in the U.S.S.R.

MISS CELIA SPALTER, a recently returned traveler from Soviet Russia, contributes to this month's department a brief summary of her photographic experiences in that country during the course of a three months' visit. She writes as follows:

"After a week or so of futile endeavor, photographically speaking, due to the countless warnings about what not to photograph and what happens to your camera if you do, I discovered that no one really knew what you could or could not photograph. Questioning invariably elicited such informative replies as 'I don't know'—'You had better ask the Director'—and so on. One answer, however, I could always count on, whether I was inquiring about taking pictures in

INSTOSCOPE



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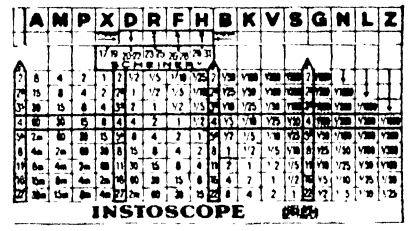

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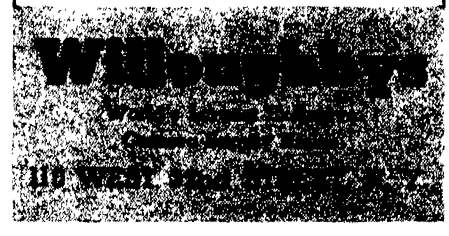

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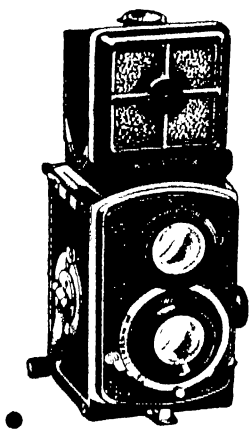

The uniquely different construction of these cameras facilitates the making of better photographs. They possess two lenses, one which takes the picture—the other which focuses your scene or subject in actual film size on a luminous ground-glass finder. These lenses are synchronized so that your "preview" in the focusing hood and your finished photograph are identical. These cameras possess, moreover, a number of automatic features found in no other instrument and represent an ultimate present-day perfection in the construction of precise, picture-making instruments.

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schools, theaters, or nurseries, was: 'You can't photograph the Kremlin or the Red Square.'

"Once I had overcome my fear of taking pictures, I found the camera an indispensable ally whenever in search not only of pictures but of adventure; for no sooner would I aim at my subject when some social-minded citizen would inquire why I was taking pictures—or some camera-minded citizen would inquire about the make and cost of the camera. In either case, the result was identical—an avalanche of questions from an ever-increasing group of curious citizens, eager to learn about America and what America thinks about them, until the snapping of pictures had developed into a sort of informal discussion meeting."

Empty Boxes

IN the course of the camera hobbyist's activities he empties quite a number of paper and tin containers and, seemingly having no further use for them, throws them away. A little thought and ingenuity will discover many uses for some of these containers. Cut film boxes and the black paper which separates the individual films may be used for storing exposed films when it is desired to reload film holders before developing the exposed films. Larger boxes may be used for storing black paper, pieces of cardboard, string, and so on—those odds and ends for which a use may be found on certain occasions, such as for masking negatives, for making test strips in printing and enlarging, and so forth. Boxes also come in handy for holding a batch of negatives which have been selected for an evening's printing, the box itself being used to hold the batch and the cover for placing the negatives when you are finished with them. One man uses the round paper container which once held a pound of hypo crystals as a measure for dealing out the "loose" crystals which he now purchases in bulk of five pounds or more—at half the cost per pound of the pound box. Thus tins and bottles which formerly held chemicals may be used over again for another purpose if we take the precaution of storing them away to await the moment when they become the solution to some disconcerting darkroom storage or other utilitarian problem of the photographer.

"Shooting" Sports

TAKE your camera to the game the next time you go and try shooting action. Understanding the game as you do—or you wouldn't be there—you will watch for significant situations, spectacular plays, and other telling incidents that occur during the course of the game's progress. And at the finish you will, if you have been industrious and agile—as well as fairly accurate as to exposure—come away with a batch of potential pictures that will vividly recall the game to you long after the action itself is over.

Generally, a lens of longer than ordinary focal length, though not necessarily a full telephoto, is needed for the majority of games, particularly those that are played outdoors. Indoors, with such games as basketball, bowling, badminton, and billiards, the lens of normal focal length will be adequate if the worker can find a place

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Leica Manual, *by Willard D. Morgan and Henry M. Lester.* A beautiful book of over 500 pages dealing with all phases of miniature photography. It covers such subjects as panoramas, photomicrography, dental, stage, and aerial photography, photomurals, infra-red, and many others. $4.00.

Practical Amateur Photography, *by William S. Davis.* Deals with the whole subject from the origin and growth of photography to the latest types and uses of cameras. 264 pages, illustrated. $2.40.

Photographic Enlarging, *by Franklin I. Jordan.* A complete treatise on enlarging, discussing not only the necessary equipment but all of the darkroom processing, dodges which may be employed, combination printing, mounting, and lantern slides. It is written in a light yet thorough-going manner. $3.70.

Free-Lance Journalism With a Camera, *by Rufus H. Mallinson.* Many serious amateur photographers would like to know how to make money with their cameras, here is a complete guide to that work. It tells not only how to make salable pictures but also how to market them. $1.65.

The Fundamentals of Photography, *by C. E. K. Mees.* Not only tells how to take and finish pictures but gives a solid foundation of the principles of photography. $1.10.

Portrait Lighting, *by Frank R. Fraprie.* Takes up the rapid development in the last few years of artificial lighting for indoor photography. $2.15.

Modern Development, *by F. R. Fraprie.* Describes all methods of development, stressing particularly modern factorial and thermo methods. All formulas are given. $1.10.

Camera Lenses, *by Arthur W. Lockett.* Explains simply and clearly, yet with scientific accuracy, all the underlying principles of lenses. 85c.

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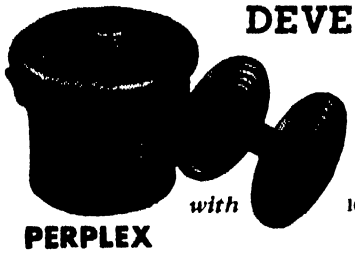

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to sit or stand that is near enough to the action to fill or almost fill the size film being used.

While any camera can be used in sports photography, only the type cameras equipped with focal plane shutters permitting speeds of 1/500th and 1/1000th of a second should be used when very fast action outdoors is to be recorded. If the fastest speed of which your shutter is capable is only 1/100th or 1/200th of a second you will do best to leave such subjects alone and thus avoid the darkroom disappointment that is sure to follow an attempt to stop 1/500th of a second action with a 1/100th of a second shutter speed. However, with some practice these relatively slower shutters can be made to stop moderately fast action if the two following precautions are taken: Shoot the action when it is diagonally opposite the camera, moving toward it or away from it—never when it is moving directly parallel to the lens. The other point applies to such sports as vaulting and similar activities involving a leap into the air. In such games the athlete comes to a momentary "dead stop" at the peak of his leap just before he descends. If you learn to make the exposure just as he reaches this peak, even a 1/100th of a second will stop him. But it will take some practice.

The fastest film available, the so-called supersensitive panchromatic, should be used for fast shooting. The camera should be of a type to permit quick changing of film so as to prevent missing "prize" shots, and for indoor sports it should be able to accommodate some photoflash synchronizing device, a number of which are now available.

Altogether, sports photography is exciting and profitable, but one must be properly equipped and learn to "size up" pictures quickly if success is to be gained.

VIEWING NEGATIVES

THE "printability" of a negative cannot be judged intelligently by holding it up to a naked light bulb. Besides being a strain on the eyes, the strong light has a tendency to wash out details and in general to kill tonal gradations, giving the impression that the negative will not print or enlarge acceptably. This is particularly true, of course, in the case of thin negatives. Now, we all know that a reasonably thin negative will make a better enlargement than a very dense one. There will be better tones in the enlargement, details will be clear and the printing time will be shorter, the latter a feature particularly desirable when enlarging on chloride or chloro-bromide papers. The best way to view a negative, therefore, is to interpose a sheet of white paper between the light and the negative, each of the three units—the light, the paper, and the negative—at a slight distance from the other. A better interposing medium is a frosted or ground glass. The regular printing box used for contact work is ideal for this purpose.

Incidentally, the miniature camera user, impatient to see his results, in the positive, has learned that when using the paraphenylene-diamine types of fine-grain developers he is able to view the film as a positive by holding the dried negative under the light against a dark background. A little experimental tilting this way and that will give the correct angle at which to hold the negative.

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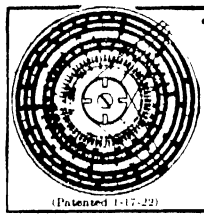
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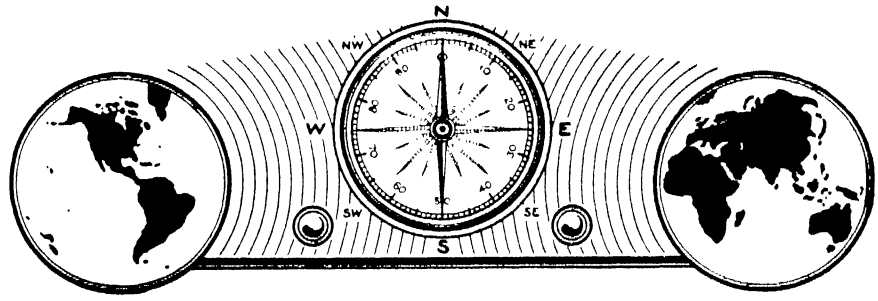
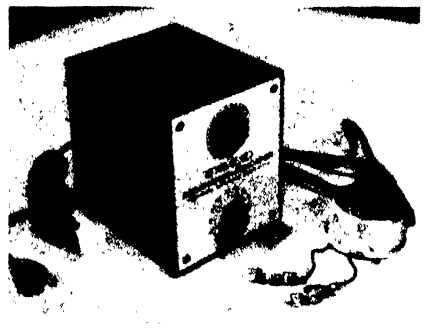


WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

Resonance Indicator

IT is extremely difficult to tune a highly selective receiver to exact resonance with a signal without some means of visual indication. Many receivers are equipped with tuning meters or "electron eyes" just for this purpose. A self-contained resonance indicator, made available by the Technical Appliance Corporation, may be easily connected to the average broadcast or all-wave receiver not equipped with a tuning indicator.


A self-powered resonance indicator for broadcast or all-wave receivers

The unit employs two 6H6 metal tubes in conjunction with a 6E5 electron-eye tube. One 6H6 is used in a voltage-doubling circuit to supply the necessary plate power for the 6E5. The other 6H6 operates as a linear diode detector, the rectified signal of which is amplified by the triode section of the 6E5 and applied to the electron-eye section of the same tube. Since the unit is completely self-powered, it does not place any drain on the receiver with which it is used.

Aside from indicating when the receiver is tuned to exact resonance with a desired signal, the resonance indicator will also show the presence of weak station carriers which ordinarily might not be heard. It is therefore of distinct assistance in tracking down weak DX stations.

The resonance indicator may also be used for aligning the r-f and i-f amplifier stages in a receiver, and as an output meter. It may also be employed for all-around servicing work on radio sets.

Radio's Political Aspect

RADIO engineers have unwittingly competed with the governmental agencies in thinking up new alphabetical combinations to characterize functions. The AAA's and the CCC's have much the same ring as many of the radio engineering abbreviations. Since some of these abbreviations are as confusing to the layman as are many of the New Deal appellations, it might be well to provide actual definitions. They are as follows:

ABC - Automatic Bass Compensation
AFC Automatic Frequency Control
AGC Automatic Gain Control
ASC Automatic Selectivity Control
ATC Automatic Tone Control
AVC Automatic Volume Control
QAVC Quiet Automatic Volume Control

The abbreviations AGC and AVC actually refer to the same function—gain or amplification—meaning much the same thing as volume.

Frequency Drift

PRECISE adjustments are required in a broadcast or all-wave receiver if all tuned circuits are to be in exact resonance or alignment. Heat alone can affect such adjustments and as a result, most receivers are aligned at the factory while they are in operation or "warm."

It is obvious, then, that when a receiver is first turned on it is out of alignment by an amount equal to the contraction of the metal in coils and condensers. The receiver is not "tuned up," in the same sense that an automobile engine is not "tuned up," until the correct operating temperature is reached. Therefore, during the first ten minutes or so signals to which the receiver is tuned may appear to drift or distort slightly.

If frequency drift or distortion is still apparent after the receiver has reached operating temperature, the difficulty is more than likely due to a change in frequency of the converter oscillator. It is not often that frequency drift can be attributed to the station to which the receiver is tuned as most modern transmitters are crystal controlled and the frequency is maintained at a high degree of accuracy.

Where to Listen

WITH the arrival of Spring, the wavelength bands below 30 meters are providing listeners with many new DX catches. The 25-meter short-wave broadcast band is particularly good now, while the 20-meter amateur band is active until midnight and after. Many of the English amateur 'phone stations can be picked up as late as 8 o'clock in the evening.

The 10-meter amateur band is "open" until early in the evening, and is practically

*Editor *All-Wave Radio*.

free from station interference. This is a "super-distance" band and is crammed full of surprises. However, very careful tuning is required. If the vernier knob is not turned slowly, most of the stations will be passed by.

The new *Detroit News* short-wave station, W8XWJ, is just a ways off the high-frequency end of the 10-meter amateur band. It will be found at 31,000 kc (31 mc), but because of the skip distance, can be heard only in certain localities. This station is on in the early evening.

Many interesting conversations can be heard over station WOU, owned by the New England Telephone Company, and used for communication with fishing vessels. The station operates on a wavelength of 119.6 meters or 2506 kc.

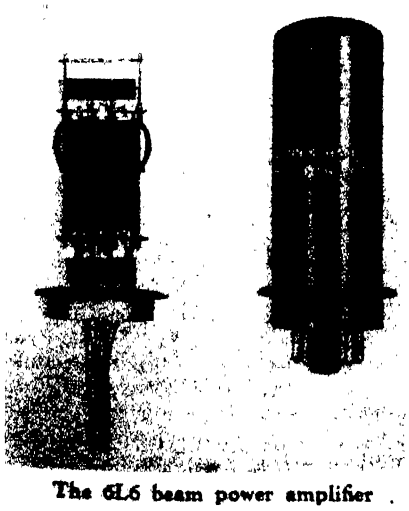
Many short-wave listeners have enrolled as active students in a course on modern radio which is being broadcast over station W1XAL, Boston, on a wavelength of 49.6 meters or 6.4 megacycles, by the Massachusetts State Department of Education. This continuous course includes a series of lectures, now going on, by Mr. C. D. Belcher, radio engineer and formerly radio inspector with the United States Department of Commerce. These lectures are given on Mondays from 7 to 8 P.M., E.S.T.

The German short-wave station DJD is back on the air on 25.49 meters or 11.7 megacycles. Particularly good reception should be had from this station during the warm weather.

Beam Power Amplifier Tube

It is a known fact that true reproduction of orchestral renditions through the medium of a radio receiver cannot be realized unless the output amplifier has sufficient power-handling ability to take care of the wide excursions in volume of the average musical selection. Reserve power is required to handle volume peaks without introducing distortion.

With the introduction of volume expansion in radio receivers [See page 223, April 1936.—*Ed.*], a demand has arisen for a tube having far greater power-handling ability than previous types of home-receiver output tubes. The requirements of a receiver having the volume-expansion feature are far more rigid than the requirements of the average receiver; to be truly effective, output powers in the vicinity of 20 watts and more are necessary in this particular type of work.



The 6L6 beam power amplifier

RCA has announced a new all-metal tube, known as the 6L6, that meets these requirements. This new power pentode has a number of distinctive features made possible by the application of new design principles involving the use of directed electron beams. The beams of high electron density are produced by constraining the electrons with potential fields set up by the tube electrodes arranged to give the desired effects in the assembled tube.

Because of the new design, this unique tube has extremely high power-handling ability, high efficiency, and high power sensitivity. With comparatively low driving power, a single tube, operated as a Class A amplifier, can supply an output of 11.5 watts to a loudspeaker. Two of the tubes operated as Class A push-pull amplifiers are capable of a maximum output of 14.5 watts. When used under Class AB conditions, a pair of the tubes in push-pull can supply as much as 40 to 60 watts output!

Tuning Indicators

An electron-ray tuning indicator can be added to any type of broadcast or all-wave receiver equipped with automatic volume control, by the use of a special adapter placed on the market by a number of manufacturers. The installation is not at all difficult.

A tuning indicator has two advantages: First, it will show when the receiver is tuned to exact resonance with the desired signal, thus insuring the listener against distorted reception; second, the indicator permits "silent tuning" from station to station. Since the electron ray immediately indicates the presence of all but the weakest station carriers, one may tune with the volume control turned to its minimum volume position.

German Television Cable

Siemens and Halske coaxial cable, constructed with a newly invented insulation called "styroflex," has been placed in use for the piping of television impulses. The cable is constructed of an inner copper wire of 5 millimeters diameter following the longitudinal axis of the cable. This wire is kept in place by a "styroflex" spiral. Around both is a foil, then a linen sleeve, and finally a lead jacket. How "styroflex" is made is not definitely known. It is transparent, flexible, and as thin as paper, and is said to be highly efficient when applied to this particular purpose.

The coaxial cable will handle 4000 kilocycles, now occupied as follows: one hundred talking bands, up to 1000 kilocycles, and a television band from 1000 to 1500 kilocycles, now used to produce a 40,000 point picture, or the equivalent of 180 lines, 25 changes per second.

Authorities claim that this cable will later be used for a television band of 2000 to 4000 kilocycles, 380 to 400 lines, 25 changes per second.

Siemens and Halske also have a new cable called *symmetrische* which they claim is as good as or better than, but different from the coaxial cable, in that the "styroflex" makes possible two longitudinal wires in the core, one of which is used to handle the return circuit instead of the usual spiral-wound copper sleeve.

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 341)

eggs also stay fresh much better in cold storage than unoiled eggs. In an eight-month storage test the original grade was retained by 65.8 percent of the eggs oiled at a temperature of 60 degrees Fahrenheit, by 55 percent oiled at 80 degrees, but by only 32.5 percent unoiled.

Eggs given an oil and vacuum carbon dioxide treatment retained 88 percent of their original grade at the end of the storage test. This method, developed by T. L. Swenson of the Bureau of Chemistry and Soils, was 35 percent more efficient than plain oiling, and 173 percent more efficient than storage with no oil treatment.

In the vacuum process eggs are dipped in oil in an air-tight chamber. Enough air is pumped out to create a partial vacuum. Some air also escapes from the eggs. When carbon dioxide is turned into the chamber the eggs draw enough oil into the pores of the shell to form a complete seal. Carbon dioxide has a stabilizing effect on the egg white. If air is used eggs do not retain their freshness.

Tractor Smashes 23 Tons of Worthless Old Drugs

ELEVEN truck loads of old drugs and patent medicines weighing more than 23 tons were recently hauled to the city dumping ground at Dallas, Texas. There a 10-ton tractor ran over them until all were destroyed.

This was the largest quantity of such products ever destroyed by Texas food-and-drug officials, who are co-operating with the Federal Food and Drug Administration in trying to stop the activities of unscrupulous salvage drug dealers. It included drugs and medicines bearing Spanish-American war tax stamps. Some were made in Indian Territory before Oklahoma was admitted as a state in 1907. Labels on bottles of "Scientific Electric Fluid" guaranteed this product to cure 37 different diseases. "Recommended for all the chief ailments known to the human system" was printed on packages containing Dr. Gary's vegetable ointment.

Although better-class druggists keep old products from their shelves, the salvage drug business became unusually active last year in Texas and other southern states. Much of the old material picked up at auctions of bankrupt, fire-damaged, or distressed stocks found its way into interstate commerce. Co-operation of state authorities with the Federal Food and Drug Administration has made it possible to confiscate and destroy large quantities of these worthless drugs.

Microscopic Chemistry

IT is frequently necessary in medicine and biology to perform an analysis where no more than a few drops of secretion or a microscopic fragment of tissue are available. In such cases the usual methods of chemical analysis are of little avail, and the technique of microchemistry was born of this necessity. Old style test tubes, beakers, and flasks have been discarded for new equipment which is more nearly comparable in size with the samples of material analyzed. Beakers of 100 and 300 cubic-centimeter capacities are replaced with microbeakers the size of a thimble. Test tubes as small as 1/50 of an inch in diameter find use in the more exacting investigations. The conventional measuring graduate is replaced with an accurately calibrated glass tube 4/1000 of an inch in diameter. A special microburner, which gives a blue flame two or three millimeters in height, is used in working with these small capillary tubes. Small platinum crucibles, beakers, flasks, graduates, and hair-like platinum wire—every piece of equipment is at least as tiny as the kitchen furnishings of a small child's doll house.

Problems of industry which were previously practically impossible of solution are now being solved with accuracy. An unimposing streak, a tiny flake of rust, and the microchemist turns detective to ferret out some industrial crime that otherwise would have gone unsuspected. One example, that of a broken wire in a resistance unit in a steel plant, is described by E. G. Van-Brunt of the General Electric Co. At first the wire was suspected of being defective, but subsequent analysis of minute particles near the break showed the presence of sulfate. The trail finally led to a nearby blast furnace which admittedly gave off sulfurous fumes, thereby clearing the wire of blame.

The serious scaling of certain chromium-alloy heating units on test at red heat was traced, through the aid of microchemistry, to improper rinsing of the lubricant in the original manufacture. Traces of sodium, an extremely destructive agent when heated with chromium-alloy materials in air, were found in the surface of the heating units. It was finally learned that the lubricant used contained a form of combined sodium which had broken down chemically to form a powerful alkali when the units were rinsed to clean them. The trouble was remedied by a change of lubricant—a cause of difficulty that might not have been discovered without micro-chemistry.—*A. E. B.*

SHOES

THE use of a new cellulose cement is revolutionizing shoe manufacture. One half of the production of women's street and dress shoes, and a growing percentage of men's shoes, are neither sewed, nailed, nor pegged; the soles are cemented to the uppers.

Nervous Breakdown Termed State of Mind

SICKNESS in which the patient's mind and nerves are upset—a nervous breakdown, for example—is not an ailing condition like typhoid fever or tuberculosis but a state of mind, Dr. Louis Casamajor of New York City recently told members of the American College of Physicians.

Typhoid fever is something which has happened inside the patient's body. Nervous and emotional sickness, on the other hand, is something "which has happened to the relationship of the patient to the world in which he has to live," Dr. Casamajor explained. The patient suffering from such

nervous sickness is up against a situation or influence in his life which he cannot take in his stride. So he becomes ill just as he would if a disease "germ" got him down.

The conflict between his instinctive urge for security or satisfaction of personal wants and the demands of civilized society makes him sick. Some of the factors which may cause this kind of sickness are the stress of war, of modern business competition, of deciding whether to return to work after industrial injury or to stay home indefinitely on compensation, Dr. Casamajor said.

Another theory of the causes of such nervous sickness is that the patient is oversensitive to either emotion or physical sensation such as pain. This view was presented by Drs. Austen Fox Riggs and Horace K. Richardson of Stockbridge, Massachusetts. In treating such patients, these doctors try first to make the patient understand the cause of his nervous ailment—psycho-neurosis is the technical term—and then to help him use this understanding of himself in learning how to live more efficiently. —*Science Service.*

Dehydration of Turpentine

When the oleoresinous exudates of various species of pines are steam distilled, the condensed distillate consists of spirits of turpentine and water. Turpentine is lighter than water and, generally speaking, immiscible with it. The two portions of the distillate are separated by gravity, the water being removed from the bottom and the turpentine from the upper part of the receiving vessel or separator. This separation is often incomplete, a fraction of 1 percent of water remaining emulsified with the turpentine which will also contain a few thousandths of 1 percent of water dissolved in it, warm turpentine holding more water in solution than cold turpentine. A warm turpentine saturated with water will, when cooled sufficiently, become turbid and free water will separate. Furthermore, droplets of water are carried over with the turpentine and as a result turpentine as sold on the primary markets and in bulk usually contains small quantities of water. The presence of water in turpentine, especially separated or free water, is very objectionable. Free water dissolves the glue coating of turpentine barrels and causes leaking, and badly corrodes iron containers and discolors the turpentine. Dissolved water alone will slowly cause rusting of iron and discoloration of turpentine.

A number of substances are known which will remove water from or dehydrate certain other substances. The substance suitable for dehydrating turpentine must be cheap, effective, and one which will not contaminate or react with turpentine. It has been found that sodium chloride, possibly the cheapest of the dehydrating agents, does not contaminate or react with turpentine and when used in a properly designed apparatus removes from freshly separated turpentine all the free or suspended water and a sufficient quantity of the dissolved water to permit the turpentine to be cooled to 10 degrees, Fahrenheit, without separation of the trace of water remaining.

Although the dehydration is not perfect, it has been found that the turpentine which has been run slowly through the dehydrator no longer dissolves the glue or glued barrels and that turpentine can be shipped and stored in barrels, black iron, and galvanized drums much longer without leaking, discoloring, or becoming turbid, provided, of course, the barrel or drum is well glued, clean, and free from rust or loose zinc oxide when filled.

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The College Man Weighs the Law is a short résumé of the various types of legal work which may be taken up by the college graduate. It is an endeavor to focus the attention of the various aspects of the profession and to serve as a general guide. Volume IV, Number 23, Northwestern University Information. *Northwestern University School of Law, McKinlock Campus, Chicago, Illinois.—Gratis.*

A Review of Railway Operations in 1935, by Julius H. Parmelee, gives facts and figures in tabular and graph form. *Bureau of Railway Economics of the Association of American Railroads, Washington, D. C.—Gratis.*

In the New Era of Motion Picture Entertainment is the annual report to the Motion Picture Producers and Distributors of America, Inc., by Will H. Hays, President. It surveys the pictures produced during the preceding 12 months, and indicates the progress and trends of the motion picture industry in general. *Motion Picture Producers and Distributors of America, Inc., 28 West 44th Street, New York City.—Gratis.*

Silent Motion Picture Films. This is a catalog of 16 mm. films, including dramas, comedies, cartoons, sports, travel, religion, education, and so on. It includes an application blank for membership in a film rental library. *Write for Bulletin 636C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

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who is a noted plant biologist on the staff of the Carnegie Institution, reveals the continuous variations in the amount and quality of mature wood laid down in tree-trunks, and describes his basic researches. *Carnegie Institution of Washington, Washington, D. C.—Gratis.*

A STATEMENT in opposition to the establishment of a municipal power and light plant in New York City and to the creation of municipal power authorities should be of interest to those who are concerned with public utilities in any municipality. *Publicity Bureau, The Merchants' Association of New York, Woolworth Building, New York City.—Gratis.*

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IF YOU SMOKE

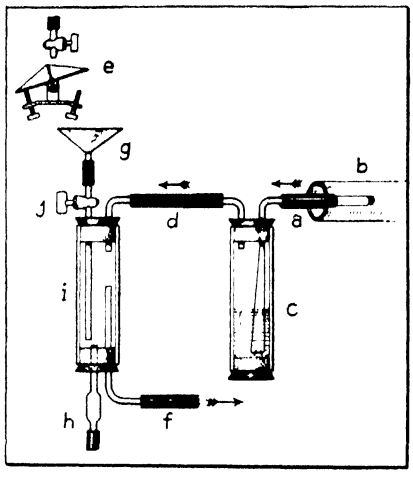
(Continued from page 313)

of di-ethylene glycol? Is the question not yet settled, or are the manufacturers too inert to make the indicated change? It is known that some of the manufacturers are studying this question, also that the existing "inertia" derives more from the consumer than the producer. Tobacco tastes are as sensitive as drinking water tastes. If the manufacturers were all definitely convinced tomorrow of a superiority, and made the change in a sudden manner, still Mr. John Public would set up an unearthly din. Re-educating John would be a costly task. The hesitation—if there is any—on the part of the manufacturers themselves is therefore understandable. "Any change in established tobacco tastes requires overcoming habit-changing resistance. A tobacco that tastes different must win its way gradually, even if it is easy on the throat, and such has been the case thus far."

Attempts to assess the various effects of smoking are so subject to the human equation that, in one experiment, Doctors Michael G. Mulinos and Raymond L. Osborne of the Department of Pharmacology at the College of Physicians and Surgeons, Columbia University, eliminated them by building a mechanical cigarette smoking or puffing machine and attaching to it a test tube containing a solution which became saturated with the smoke. Then they instilled two or three drops of this solution into the conjunctival sac in the corner of a rabbit's eye and noted the amount of swelling, redness, and objection by the animal. It was found that the swelling (edema) produced by the smoke-solution

from cigarettes which contained no hygroscopic agent lasted an average of 31 minutes, that from di-ethylene glycol treated cigarettes 8 minutes; and that from glycerine treated cigarettes 45 minutes. On increasing the percentage of glycerine the irritation was slightly increased, but a similar increase in the percentage of di-ethylene glycol caused it slightly to decrease.

The puffing machine is shown in the illustration. It was adjusted to take four-



The puffing machine, which eliminates the uncertain human factor

second puffs once each 15 seconds until the cigarette is consumed to the butt. The cigarette is inserted in the end of the horizontal tube *a*, and the large, loose tube *b* is placed around it in order to keep off drafts which would otherwise alter its normal speed of burning. From the cigarette, the tube *a* leads down close to the bottom of the water in *c*, and when suction from an air pump is applied at *d* the smoke is drawn into the water, which dissolves its contents as in the oriental *hookah*.

The remainder of the apparatus is for the purpose of giving the intermittent puffs. The suction pump is attached to *f* and, as long as nothing plugs the openings in *i* (at *g* and *h*) the suction at *f* merely draws in air at these openings. But if water is suddenly dumped into the funnel *g* this water not only prevents ingress of air there, but the water, running down into *i*, also plugs *h* until it runs out. The suction applied at *f* is then passed along to *d* and the cigarette.

Instead of having a man stand by the apparatus occasionally dumping water into the funnel, in order to make the cigarette puff, a tipping bucket shown at *e*, is used, as in standard laboratory practice. This is simply a square of metal bent along its diagonal into a curve, supplied with a transverse partition as shown, and pivoted at its bottom center. Water from a tiny stream above the bucket slowly fills one side until it overbalances, spilling the water out and into the funnel. Then the other side fills and tips into the sink; and so on and on, at intervals determined by adjustment of the incoming stream and of the stops beneath either side. The stopcock at *j*, if closed, would render the smoking steady instead of intermittent, provided *h* were also closed, but was not used in this experiment.

As stated by these Columbia University pharmacologists after their experiments, "it is obvious that the cigarettes which had been made with di-ethylene glycol as hygroscopic agent proved to be less irritating than those with no hygroscopic agent, and much less irritating than those with glycerine."

The amounts used were those ordinarily used in the manufacture of cigarettes, that is, 2.74 percent di-ethylene glycol and 3.65 percent glycerine.

Similar experiments were made by Wallace, Reinhard, and Osborne of the New York University College of Medicine, and the findings gave a close agreement with those just described. The duration of irritant effects from the glycerine treated cigarette was also found to be much longer than with the di-ethylene glycol cigarettes.

What about the acidity of tobacco? According to the *Journal of the American Medical Association* "there seems to be no evidence that the acidity of tobacco smoke is of the slightest importance to the health or to irritation of his throat by the tobacco." Perhaps the talk of acidity is a smokescreen.

What, then, of smoking? Has science an answer to the question whether smoking is harmful? How much ought an individual to smoke?

SCIENCE need not answer these questions, for they have already been answered by tests on more than 100,000,000 guinea pigs – those of us who smoke. Most smokers – probably all smokers – are doubtless harmed to some extent, usually not great, by smoking. Likewise, most or nearly all smokers derive some pleasure and satisfaction from smoking. As Professor Mendenhall says, a packet of cigarettes is a "packet of rest," and the same is true of cigars and the pipe. That is, tobacco is a mild sedative – it quiets our nerves. Most of us contrive, generally without thinking, to adjust the extent of our smoking in such a way as to make a net gain of smoking satisfaction over smoking harm. The few who do not, do not employ their entire intelligence or else they are too weak to do so even when they sense its need. As it probably will do little or no good to preach to this minor fraction, we pass on. The average intelligent smoker senses when he is smoking too much, because he does not feel well, and he eases off, often unconsciously.

Scientific experiments, then, are interesting, and the findings derived from them provide us with something interesting to talk about with other smokers while we smoke. But the human race has already tried out the tobacco experiment and finds perhaps something like this: smoking does not do a great deal of good but it does not do a great deal of harm. Most members of the same race, smokers included, would also agree that smokers in general would be much more widely tolerated by other members of it if they would bury their butts six feet underground.

•

One of the most provocative features of this review is the discussion of the present controversy over the relative merits of glycerine and di-ethylene glycol as hygroscopic agents. Doubtless this argument will continue for some time. Scientific American *will, therefore, keep in close touch with the situation and, when further findings of sufficient importance are reported, pass them along to its readers.*—

THE EDITOR.

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By J. Harry Howard

Here at last is something of a real book on a subject concerning which there have been little more than pamphlets, and mighty few of these. One of these was the one dollar sketch, "The Working of Semi-Precious Stones," by the same author, who also wrote, in Scientific American, March, 1932, an article on amateur lapidary work or gem polishing. Howard's newest book now provides practical instruction in all kinds of gem cutting for the beginner and for the advanced amateur. Its accent is on the practical, for this is a real shop book that tells not merely a lot of generalities about lapidary work but actually how to do it, how to set up the rig to do it with, and even where to get the parts of that rig. Lapidary work was much of a trade secret till Howard bored in, learned the methods and, by means of his books, turned the secrets into a fascinating hobby for everybody.—$2.15 postpaid.

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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COVER

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AMONG the mammals preserved in the newly opened African Hall at the American Museum of Natural History, New York, is the mountain gorilla shown on the front cover. The late Carl Akeley deserves and has been given the major part of the credit, not alone for making possible, through his enterprise, this new monument to the passing wild life of Africa, the African Hall, but for preserving in Africa, alive and closely protected, the remaining gorillas. Disgusted with the earlier taxidermy which consisted merely of "stuffing" animals, Akeley, himself a sculptor, invented new ways of mounting them artistically. He knew his gorillas, having almost lived with them in Africa, and his observations dispelled earlier fables about them. Gorillas, if made to fight, are terrible opponents but, like nearly all animals including the more intelligent specimens of *Homo sapiens*, they avoid a fight whenever it is expedient. The big male shown on the cover weighed nearly 500 pounds.

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50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of July, 1886)

LICK TELESCOPE—"The trustees have awarded the contract for mounting the 36-inch objective (now in the hands of the Messrs. Clark, of Cambridgeport) to the firm of Warner & Swasey. The telescope is to be 57 feet long; the diameter of the tube is 42 inches. The tube is suspended at the middle, and the point of suspension is to be 37 feet above the floor of the dome."

ELEVATED RAILWAY—"The system herewith illustrated is the invention of Mr. Joe V. Meigs, of Lowell, Mass., and has been tested under conditions far more exacting than would be found in actual practice. The trial road, beginning at the shops of the company on Bridge St., East Cambridge, has one curve of 50 feet radius, 165 feet long, on a grade of 120 feet, and on level and curves has grades of 240 feet, 300 feet, and 345 feet. So far everything has worked in the most satisfactory manner, the train rounding the exceedingly sharp curves easily, and mounting the steep grades without trouble."

IRON AND SUGAR—"M. M. Klein and A. Berg have been studying the action of sugars on the corrosion of boilers, and find that sugar in water has an acid reaction on iron, which dissolves it, with a disengagement of hydrogen. The quantity of iron dissolved increases with the proportion of sugar in the water. The salt of iron formed is the acetate. These results are worthy of note in sugar refineries and places where sugar sometimes finds its way into the boilers by means of the water supplied."

PROGRESS—"Prof. R. H. Thurston, Director of Sibley College, Cornell University, in his lecture before the graduating class of the Rose Polytechnic Institute, at Terre Haute, Ind., took for his subject the nation's great problem, the possibility of progress without revolution and without those periods of darkness and distress which have heretofore been its recording milestones. The solution of this problem he finds in education, the careful, moral cultivation of the people at large. . . . In the ideal education, the citizen is fitted for the pursuit of every desirable object in life."

A T & T—"The American Telephone and Telegraph Company of New York has recently been organized for the purpose of establishing direct telephonic communication between the large cities of the country. The first line has been constructed between New York and Philadelphia . . . about 100 miles."

DYNAMITE GUN — "Lieut. Zalinski is still continuing his experiments with the pneumatic dynamite gun. The weapon is 60 feet long and has a bore of 8 inches, the projectile force being air under a pressure of 1,000 pounds to the square inch. When the gun was elevated 32 degrees, the projectile was carried about two and a half miles."

WATER POWER—"Nowadays, when so many of the small cities throughout the country are supplying themselves with water works, it seems time to notice a class of small motors in which the water pressure can be utilized to develop power for driving such various kinds of machinery as are usually operated by hand."

EXPOSITION—"The people of the beautiful and enterprising city of Minneapolis, Minn., are actively engaged in arranging for their grand industrial exposition, which is to be opened on the 23rd of August next. The exposition has obtained, by donation of citizens, a site of 5½ acres of ground in the heart of the city, a central and commanding position overlooking the Mississippi River and Falls of St. Anthony."

COMPETITION—"The manufacturer who hopes to hold his own in the fierce competition which characterizes modern industry must of necessity keep a sharp lookout for valuable improvements in machinery, and must introduce them promptly when they are presented. The movement of the industries is always forward. Thousands of ingenious minds are continually studying out methods for making processes easier and more economical."

THERMO ALARM—"The thermometer figured herewith is designed for giving indications as to the temperature of silos, grain depositories, piles of coal, or certain fabrics that are apt to burst into flame spontaneously and set fire to factories or ships. The apparatus is connected with the exterior by means of conductors that traverse the surrounding substances, and that serve to indicate, at every moment, that the temperature has or has not reached a dangerous height. As soon as the needle of the thermometer strikes an index, placed at the degree of temperature that it is important to know (showing danger of fire), a bell rings."

CABLE—"At present, when telegraphic messages are sent from the United States to Brazil, they must first be cabled to Europe, and then sent from there to their destination. A new enterprise has just been organized in New York for the construction of a direct cable from this port to Venezuela and Brazil."

BENDING BUILDINGS — Expansion and contraction of building materials have "been noticed of late in structures of stone and iron. The Washington Monument leans to the east in the morning and to the west in the afternoon. A plummet line suspended in the interior of the dome of the Capitol at Washington was found by actual measurement to swing over a space of 4¼ inches, making a total dip from the perpendicular of 8½ inches. This movement involves the entire dome. Some years ago a learned monk in Rome suspended a plummet in this way from the top of the dome of St. Peter's and was astonished to find this mysterious movement."

AND NOW FOR THE FUTURE

¶Are Modern Streamlined Automobiles Safe to Drive? By Professor Alexander Klemin

¶The Present Status of Air Conditioning Equipment for Home, Office, and Factory, by Philip H. Smith

¶Straightening Out the United States-Mexico Boundary—an Engineering Feat of Unusual Interest

¶Recent Progress in Seismology, by the Noted Priest-Seismologist Father Joseph Lynch, S. J.

¶The Bronze Age Woman of Denmark: Fascinating Archeological Discovery of a Real Blonde

¶Liquid-Propellant Rocket Development: A Conservative Account of Rocket Research, by Professor Robert H. Goddard

Personalities in Science

JOHN G. KIRKWOOD

JOHN GAMBLE KIRKWOOD, who in his twenties has outdone the world's best minds in solving long-standing problems of molecular chemistry, has been awarded the 1000 dollar Langmuir prize of the American Chemical Society for 1936. Kirkwood, 28, an assistant professor in Cornell University, was picked as the most promising young chemist in America.

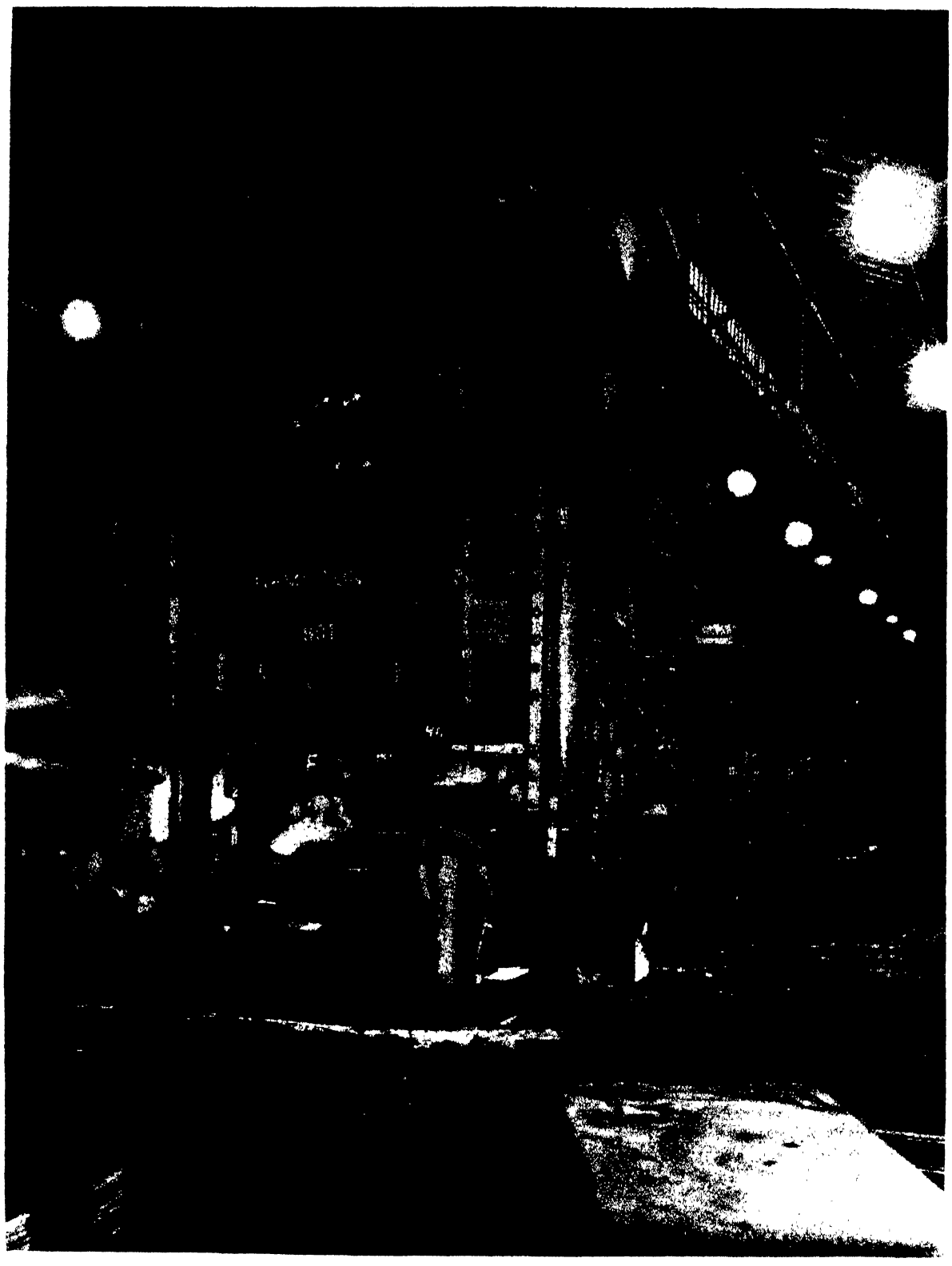
"Kirkwood's contributions are outstanding," declares the announcement of the committee of award. "He has succeeded in instances where older and more experienced men of proved ability have failed to arrive at definite results. In early papers, Kirkwood showed an intuitive grasp of applied mathematical technique and scientific insight exceptional in one of his age. Later papers are entirely independent contributions in which important advances are made in the computation of the intra-molecular field of non-polar and polar molecules."

Our representative, after calling on Prof. Kirkwood at Ithaca, writes: "In his plainly furnished quarters, surrounded by books and technical publications, with an automatic computing machine near his desk, Dr. Kirkwood looks every bit the scholar which his rare honor indicates. His sandy-colored hair, slight frame and fair complexion, give unmistakable evidence of his youth and of his Scotch-Irish ancestry. His massive forehead is accentuated by his prematurely thinning hair. Modest and unassuming, he greets callers in a friendly manner, with almost an apologetic attitude for having created so much of a stir and for being unable to point to any promise of revolutionary practical results from his work. He is purely a theoretical chemist and his office is totally devoid of any of the trappings of a chemist. In fact there is not even a chemical odor. He has no hobbies, though he plays a little tennis and smokes a pipe. He refuses to surround his work with glamor or romance, feeling that it is pretty prosaic stuff and something which can only challenge the imagination of a scientist concerned with pure theory. 'My work is highly technical and theoretical and not exciting enough to talk about' he stated.

"His program, he advised me, centers around the general problem of determining the relation between the properties of substances in bulk and the structure of their constituent molecules. The theoretical aspects of this problem fall into two classes: (*a*) The application of quantum mechanics to a study of inter-molecular forces and their potentials in relation to atomic and molecular structure. (*b*) The development of theoretical methods based upon statistical mechanics for the prediction and calculation of the thermo-dynamic properties of substances from a knowledge of the inter-molecular forces. Present work is chiefly concerned with problems of class (*b*) with reference to liquids and liquid solutions.

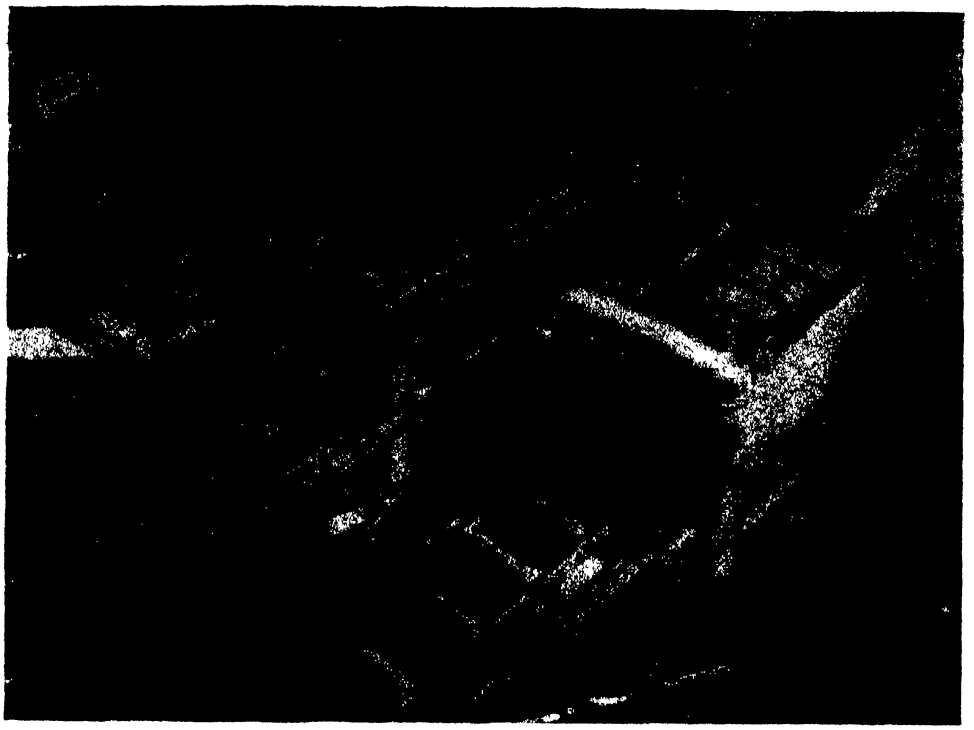
"Specific theoretical problems now under investigation or planned for the near future are the following: Extension of the Debye-Hückel theory and the calculation of ion pair distribution functions in concentrated electrolyte solutions; Further application of the theory of Zwitterion solutions to the higher members of the aliphatic amino-acid series and their peptides; Statistical critique of the Bjerrum theory of ionic association; Influence of intermolecular forces on dielectric polarization; Modification of the Lorentz theory; Influence of the dielectric constant of the solvent upon the Raman frequencies of polar solutes; Further investigation of the relation between quantum statistics and classical statistics.

"Work is already in progress on a study of the dielectric constants of solutions of the amino acids in non-aqueous and partially aqueous solvents. Other experimental investigations planned for the near future are the following: Measurement of the freezing points of binary non-electrolyte solutions and measurement of the electromotive forces of concentration cells with transference, involving mixtures of electrolytes and non-electrolytes."



IN A VALLEY OF NOISY GIANTS

THESE giants of modern times must be modernized each year—because of changes in car styles—and here the machine designer has an opportunity to draw upon his experience and exercise his genius. Basically, the design may remain the same as before, but changing automobile body styles make necessary much expensive re-tooling and altering of machines. These huge presses in a Chrysler Motors plant stamp out fenders for this year's Plymouth cars. They range from 10 to 35 feet in height, weigh as much as 400 tons, and are imbedded in massive steel and concrete foundations.



A sales "device"—sliced bread—mothered this machine. Loaves, placed by hand on the conveyor, are cut by knives—one for each slice—and are carried to the wrapping machines at the rate of 2000 sliced loaves per hour

Breeding Machine Brains

Machine Design Evolutionary . . . Basic Design Ideas . . . New Materials, Processes Demand New Machines . . . Empirical Designer Most Successful

By PHILIP H. SMITH

MACHINES have been given the sense of sight, taste, touch, hearing, balance, and direction, and the ultimate goal is to endow them with brains.

What is the photo-electric cell applied to a machine but the endowment of sight? If a boiler raises an outcry when impurities enter the water that feeds it, that shows a sense of taste. Many machines demonstrate the capacity to feel by reacting to temperature changes, while the Gyro-pilot, which aids the operation of air transports, possesses both a sense of balance and one of direction.

Here, in this evolutionary development which has made machines more than mere creatures of muscle, is a fact which opens the way to discover how machines come to be and what the breeding process promises for the future.

Machines are not all equally advanced, but all design follows the evolutionary process. As talents are needed, they are imparted. Today, engineers say confidently that they can "humanize" machines to solve almost any problem, and they have been so busy working at it that all industries are sudden beneficiaries. Everywhere there are new machine tools, new automatic devices with which to improve quality of products, to lower the costs of production, or to relieve workers from the fatigue of repetitive operations or undue muscular effort.

Perhaps you have sometimes wondered how these mechanical marvels came into existence. Maybe you have watched a complex mechanism swallow raw material, subject it to different treatments, and spew it forth in the form of highly finished products; and you have pondered how the human mind could have conceived such an intricate design to accomplish a predetermined end. None of this is easily disclosed, because, despite the seeming orderliness of machine development, it is a most disorderly and unplanned business; in fact, it isn't so much a business as an art.

INGENUITY is a primary requisite for machine designing success and this may be found almost anywhere. Most practical designs come from "shoemaker mechanics"—those who work without benefit of formal training but with plenty of shop experience. The college-trained man does not take kindly to machine design and isn't prominent in the field. Too often he lacks the patience to acquire the practical side which alone can lift him to the top of the heap. Competent engineers declare that training in theory, without the practical side, tends to make a designer too conversant with what can't be done, too aware of supposedly inviolable principles, whereas what he needs is an untrammeled mind which knows when to make departures.

Before the first bright idea emerges there must be a need, otherwise the idea isn't bright, and need makes every design problem unique. Probably there are as many ways of tackling the problem as there are men to do it, but a few principles of approach are being laid down to increase efficiency in reaching solutions. Practically all designers agree that a problem can be handled best by first stating it in the most accurate engineering terms possible, because the delineation may reveal clues to the solution. Beyond this point logic begins to yield to "hunches"

A master craftsman guides a carving tool over a finished leg model and a carving operation is performed on eight other legs. After this roughing out, legs are finished by hand

even with those who pride themselves on the sound progression of their reasoning.

A designer can rarely tell where he got his basic idea. To say that a machine stemmed from this or that is like trying to fix the point in the heavens from which a meteor began its flight. You see its brilliance as a fact, but its origin remains forever obscure. Coming out of nowhere as a creation, the first tangible evidence of an idea may be a few pencil marks on the back of an old envelope or a rough sketch on the tablecloth of a restaurant. But every idea has its catalyst and many of these can be enumerated.

MACHINES themselves suggest new machines. They prompt modifications, refinements, and new groupings of functions. This is evolutionary in the real sense. New materials often serve as catalyzers because they suggest new paths to explore. Advances made by one industry suggest adaptations for another. The whole mass-production idea provides an example, because the success of automatic machinery in one place prompts its trial elsewhere.

All of this imposes upon the designer the necessity for keeping abreast of developments in all fields. It demands that he use all agencies such as the technical press, actually inspect machines in alien fields, and become conversant with the properties of new materials. There is no foretelling where the catalyst may hide. A manufacturer of wood pulp products, for example, got the idea for a beater from an advertisement of a dough mixing machine. A mayonnaise mixer provided the necessary idea to a designer who was developing a new ceramic. An engineer who is about to launch a much improved gear grinder got his chief inspiration from a hobbing machine.

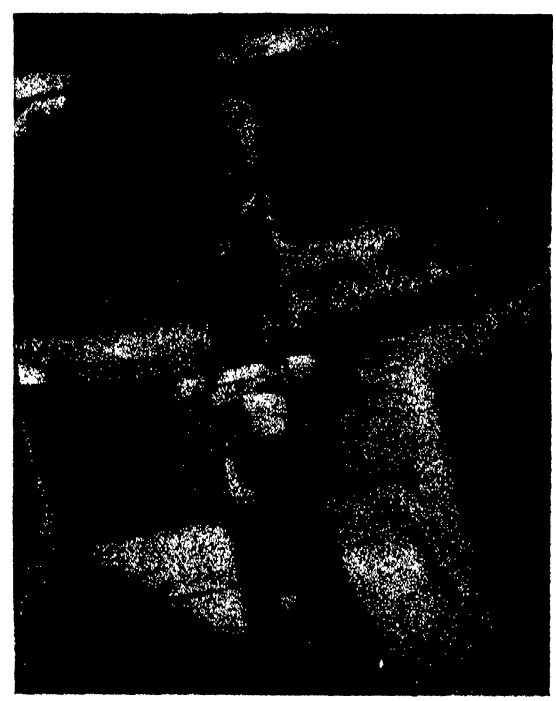
One of the most striking machines exhibited in recent months unquestionably was inspired by contact with previous machines in the same field. What makes it outstanding is its ability to perform in sequence a number of operations hitherto performed separately in the manufacture of bolts. Combining operations makes for economies in handling. The machine isn't much bigger than an office desk, yet it takes wire from a coil, cuts off a bolt length, cold heads one end, points and threads the other end and drops finished bolts into a bucket at the rate of 75 a minute.

If it is correct to say that many ideas are wholly accidental in their origin, it is only another way of saying that observation plays an important rôle in design development. A case in point is a completely automatic machine for knitting fancy hosiery. Many years ago someone noticed that a circular and full-fashioned knitting machine, when running two threads, occasionally criss-crossed by accident so that the outside thread became the inside one and vice versa. When threads of different color were used, an irregular pattern resulted. From observing this phenomenon came the "hunch" that control of the criss-crossing would permit the knitting of any desired pattern, and today this is being done.

Obstacles frequently act as a spur to the inventive mind, and, of course, a patent is the best form of obstacle. One automatic machine, still unveiled though running 24 hours a day, represents an eighth attempt at surmounting an impregnable patent wall. The first six attempts ran head-on into other patents, and, as the designer says, "Process of elimination won."

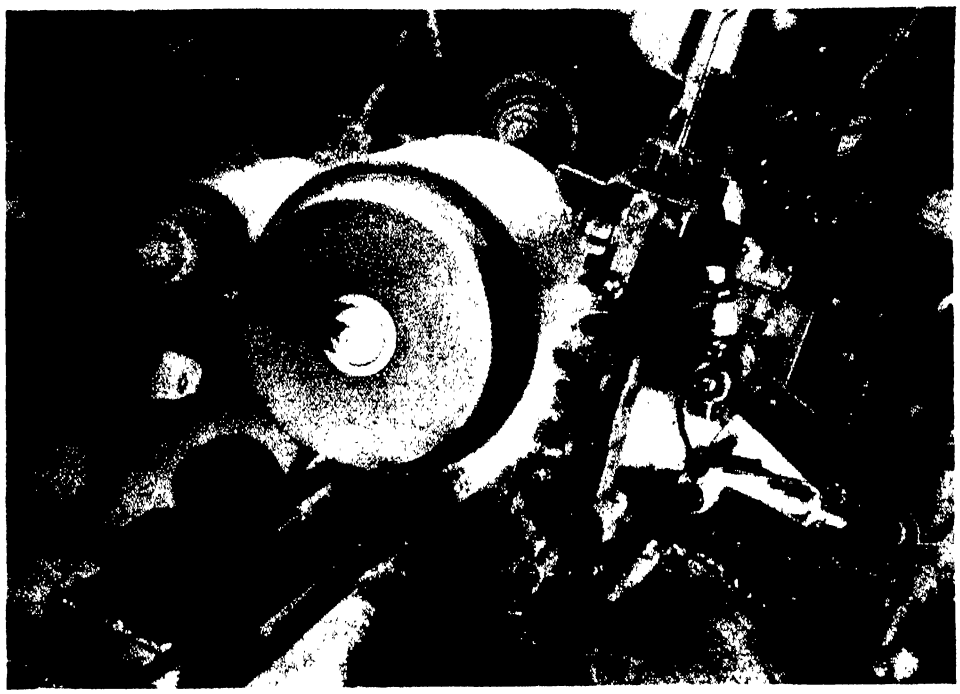
"It can't be done" is a phrase that is immensely stimulating to the really ingenious person. Overcoming the impossible produced the cigar making machine impossible because tobacco leaves vary in size, shape, and structure. Twenty-five years labor and about 5,000,000 dollars in expense created a machine that will make 480 complete cigars per hour, in a continuous, sequential operation. First a bunch is formed, then it is wrapped in a binder, trimmed, and finally enclosed in a leaf wrapper. Present machines are basically the same as the original, but refinement of detail mechanisms make for better quality products.

Among the factors limiting the solution of a design problem, the economic factor is always decisive, and that is why the best designers are those who combine an appreciation of the economic side with their capacity to create. Quite recently a machine was developed for polishing automobile hub caps and the specifications acting as limiting factors



Dough is made by this rounder into balls, which are later molded by machines into loaves

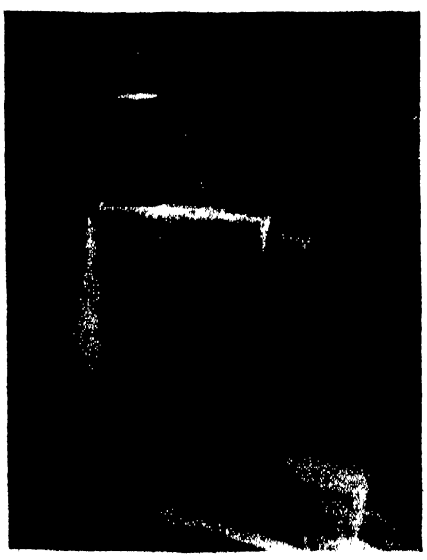
were: delivery to the cap manufacturer in eight weeks; an output of 800 caps per hour; and the capacity to polish a variety of other small parts. Delineation of the problem established three aims for pursuit to meet the exigencies of time and cost. As far as possible existing units were to be used, welding was to be employed to avoid the delay involved in pattern making, and standard unit parts were to figure as prominently as possible in all sections of the machine. The machine as finally developed exceeded output and delivery specifications which goes to show how far the technique of design has been carried.



Tubes for tooth paste are made on this machine which trims both ends, threads the neck, and gives base coat of paint. The tube, on a spindle, spins its way to completion

People who marvel at the proliferation of machines probably fail to realize not only the evolutionary nature of development, but the wealth of opportunities contributed by other contemporary developments. "Every time a new material is described, I can think of about 500 applications," says one engineer. Development is fan shaped, on many salients, and the give and take on many fronts fructifies the inventive mind.

Contemporaneous development creates the need for new machines and demands that existing machines be improved. Cemented carbides hadn't been long on the market before they precipitated a whole chain of events. Carbide dies for the drawing of wire have to be drilled to exact limits with diamond dust. An early ripper machine designed to perform this drilling had a spring to exert the proper pressure on the drill and a cam action to raise and shift the position of the drill while more abrasive was added by hand. Today's machine, a great grandson, in addition to being a self-contained unit, more precise in action, embraces an automatic abrasive feed by means of a controlled pump.



A new machine in the making; and a complex, heavy lathe does the job

Cemented carbides, by virtue of their capacity to cut metal at high speed and for long stretches without losing their sharpness at red heat, forced advances in design of machines which employed them in the form of tools. Existing lathes, for example, would not permit the carbide cutting tools to be used to their maximum advantage. What then? Machine designers got busy and within a couple of years a flock of new machines appeared on the market.

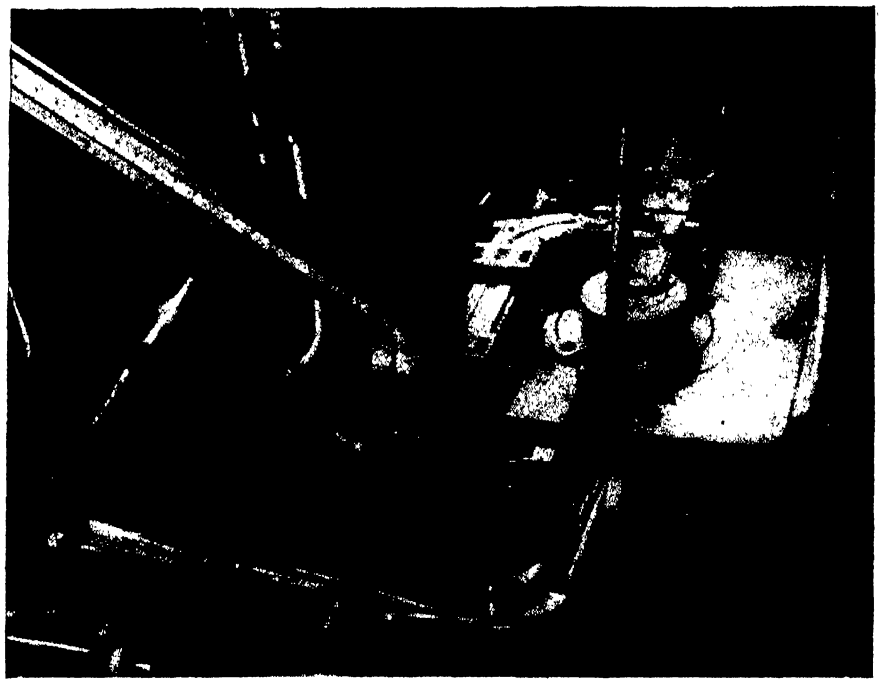
HIGH-SPEED cutting imposes greater strain upon the machine operator, so design took this into consideration. Controls were made more automatic and built right into the machines. The latest in variable drive mechanisms and gages for measuring work in progress down to thousandths of an inch humanized these mechanisms.

Notable advances have been made in matters affecting safety of the operators wherever speed and hazard are combined. The automatic shaper in the wood-working industry has forever eliminated the mutilated hand or finger as a testimonial of skill and experience in this field. The design is such that rotating knives cut in the direction of feed and cannot draw hands into the path of danger. And this pays, because production speed has been increased enormously and a more accurate cutting operation is performed.

New materials are the inspiration for many striking machines for which there was no need only a few years ago. When die casting experienced a re-birth as the result of research which made pure zinc a reality, new casting machines were needed to speed operations. When plastics began to be appreciated as a material which could advantageously supplant many others, there came a call for presses to be constructed of metals which would remain unaffected by the synthetic compounds. Adoption of a soy-bean plastic by one of the large automobile manufacturers will require 400 presses of new design. One such press molds plastic window frames and completes the operation in about five minutes. Press design is evolutionary and therefore it is not strange to find these machines being built by old line concerns.

The fickle consumer, a constant source of headache to engineers, is also a contributor to design progress. When milady calls for pastel shades in textiles, she gets them, but to the designer the demand meant a problem. His job was to make textile machinery clean in operation and he did it by incorporating oilless bearings. The American public would not purchase a new car every year if it were not for style changes and these invariably call for some alteration in machines. Body streamlining requires deep drawing of sheet metal, recently made feasible by metallurgical advances and press design.

In no industry is the need for design change and the need for design stabilization so intense as it is in the automobile industry. Mass production welcomes machines which will perform several operations simultaneously and manufacturers will pay handsomely to get them. Especially built, single-purpose machines meet this need, but with product design changing annually, there is a supplementary and insistant demand for



The machine which extrudes the metal tubes for various creams, and then ejects them by air to a conveyor belt which carries them speedily to finishing machines

flexibility without sacrifice of efficiency.

Discoveries of new physical laws and principles are a potent source of ideas for machine design and are most likely to give a big jump forward. When applied in a practical manner, they give rise to a new chain of developments. The photo-electric cell, which bestows the gift of sight to machinery, is responsible for the development of machines which wrap consumer goods with more than human precision, sort objects according to color, candle eggs, and perform other functions where the power of making a choice is desired.

THE extraordinary breeding of new machines during the past half dozen years might lead one to conclude that there are very few worlds left to conquer. But the fact is that the ultimate goal is a long way ahead. There can be a vast development, even if machines are never given brains.

Design progress is not equally advanced in all industrial fields. There are many backward industries awaiting someone to conceive the need for machines and the tremendous possibilities inherent in them. There is enough ingenuity in the country to accomplish this once the drift is felt.

The new materials being born every day afford another stimulus to machine design. Even a greatly improved material does this. Each material represents a different grouping of qualities and properties to multiply opportunity. Metallurgical progress of the past few years alone has made countless machines obsolete when judged by the new standards of performance they create. The practice of alloying which has done so much to bring forth new machine designs is still in its infancy. A prominent metallurgist has calculated that the 40 metals which can be used as alloys afford 102,050 possible combinations and if it is assumed that a variation of 10 percent in the concentration of one element constitutes a different alloy, the possible combinations rise to more than eight million.

Fabricating methods vie with materials in bringing inventive genius to the fore. The substitution of welding in the manufacture of machines formerly made of castings already has produced many design changes and improvements. Elimination of metal formerly required to impart strength, but having no other structural advantage, permits an entirely new conception of what a design may be.

Unexploited ideas should not be overlooked as a possible source of machine advancement. There are many which will remain veiled until a need arises to justify their being developed to the practical stage; there are others which cannot be utilized on economic grounds, but which may be exploited in the future. Both these potentials are exhibited by the gyroscope idea. Practical application was first made in the marine field when the Gyro-stabilizer was installed on a naval vessel. At that time there was no recognized need for a similar device to aid in aviation. The first successful application of the Gyro-pilot to aircraft came in 1915, but it wasn't until 16 years had elapsed that it flew the first transport plane. In the interim, the device was perfected, its weight was reduced more than half to make it practical; and, coincidentally, commercial aircraft were developed to a point where there was a distinct economic need for some device that would have "brains" enough to aid a pilot.

Evolution works slowly in machine design because it retards development as well as stimulates it. What has gone before provides a springboard from which to make departures, but also it determines the point of departure which may not be the best one. We get a suggestion of this in the work that is done to establish scientific bases for what has come to be accepted as fact. Machine development often seems to reach a stalemate by following traditional paths, then upsetting tradition gives it a new lease of life. Frequently needs arise faster than existing machines can meet them without drastic design changes.

IN recent years cables have been called upon to take higher voltages and heavier loads with a resultant increase in their failure. Cognizant of the new service requirements, one progressive organization has inaugurated exhaustive studies of lead sheath. Among the many discoveries already made, the fact came to light that sheath extruded at 20 feet per minute has a greater physical strength than when a rate of 60 feet per minute is employed. Such studies as these are of the tradition-smashing type which affect machine design.

Needs for machine progress and the materials for accomplishing it are assured, but the future development hinges upon the available supply of men with imagination, ingenuity, resourcefulness, and initiative. All these qualities are essential if man is to weave new strands into our industrial fabric through the agency of the machine. No one questions that such material is available, but on many sides there is grave doubt that present training will make it consistently fruitful.

"Unless the apprentice system comes back," says one engineer, "we must expect a slowing down of machine development." "Training in overalls is so vital," says another, "we have had to establish our own shop training," while another director of a machine designing organization declares: "Skill in machine designing doesn't come from books. We need college trained men who are willing to take off their collars long enough to get the practical feel."

Machines are the wonders of the age because they have traveled an evolutionary course. And the men who made them do it, themselves traveled an evolutionary path of training. Is the machine frontier to remain unexplored because the oncoming generation lacks the equipment to tackle it? If that time ever does come, then and then only will the machine become man's master.

Photographs by Ritasse, Courtesy The Sherwin-Williams Co., Sun Tube Corp., The Williams Bakery, and W. & J. Sloane.

OUR POINT OF VIEW

Two Years to Go

OUT of the mists that have so long surrounded the television situation, there recently came a faint glimmer of light. Laboratory developments have reached a stage, according to RCA engineers, where the next logical step is the inauguration of field tests, but—and this is a big "but" for the general public—television for home entertainment on a scale comparable with motion pictures and radio broadcasting is still definitely in the future. How far in the future it is difficult to say. Engineers put it at least 18 months away. Our own venture is two years or more—probably more.

At a demonstration of the best television reception which we have ever seen, indoor and outdoor scenes were televised with the iconoscope, sent by short-wave radio, and reproduced by the kinescope. The equipment used was developed by Dr. V. K. Zworykin and has been described in our issues of February 1930 and September 1933. Laboratory developments have improved this equipment to an extent where the reproduced picture in the present experimental models is approximately nine inches wide and of good detail. Viewed from a distance of five feet or so, the image is comparatively free from "graininess," and detail is as good as might be found in a newspaper halftone reproduction of similar size viewed from a similar distance.

Following this demonstration, the radio and scientific press was treated to a heart-to-heart talk with RCA engineers on the immediate future of television. With commendable caution, these engineers refused to commit themselves to any definite statement regarding the exact time when television will "enter the home," what the equipment will cost, or even what form it will take. This leaves lay observers in the perhaps unenviable position of drawing their own conclusions, based upon their analysis of objectives achieved and the possibilities of laboratory developments in the immediate future. One thing is certain: the field tests which already have started may possibly result in turning the whole problem back to the laboratory to iron out the "bugs."

Assuming, however, as we may well do under the circumstances, that the "bugs" are minor and that extensive and careful field tests show television to be ready for the public, the technicians will face a problem complicated by advances made in other fields of entertainment. The public demands and gets high quality motion pictures, either in the theater or with home movie outfits. Radio broadcast entertainment has reached a high peak of technical efficiency. Thus television, when it is ready, if it is to be received as something more than a mere novelty, must be able to compete rather closely in quality and flexibility with these two established forms of entertainment. From a commercial point of view, television will probably supplement them: the competition we refer to is for public acceptance and continuation of interest, and is not intended to indicate a commercial competition.

From the point of view of those interested in the promotion of television, the questions now arise: Will the public, blasé because of a take-it-for-granted attitude toward radio broadcasting and motion pictures, be satisfied for long with television reception of pictures small in size and comparatively lacking in detail? Will they accept the limitations of image size and program scope in television reception?

Television has come a long way since its beginnings, although on the other hand it has been a long time in reaching its present stage of development. Remarkable progress has been made in a field that presents difficulties perhaps unmatched in any other line of scientific research. But there is a long, hard road ahead before television becomes a commonplace in our everyday lives. That the many obstacles will be overcome there is no doubt; the tantalizing fact that the problems seem insoluble may be the very spur needed to urge the television engineers toward their still distant goal.

In the light of the present developments in the laboratory and of the possibilities to be expected from comprehensive field tests, we venture a prediction: Television entertainment on regular programs will not be available to the public for at least two years, at which time there will be on the market television receivers with the limitations mentioned above. Public acceptance of this radio service will be small at first, but the very fact that television may be had at a turn of the dial will be an incentive that will eventually produce television receivers in which the image will compare favorably with home movies in both size and detail. When that point has been reached, the engineers may well feel that they have accomplished a feat of great magnitude.

Conservation Progress

TROUT streams and game coverts, bass lakes and big-game ranges are the natural heritage of this continent, but a heritage that has been squandered, laid waste by greedy commercial interests with an eye to profit and with no respect for the needs or wants of the general public. It is, therefore, with no little pleasure that we read the progress report of the American Wildlife Institute, organized last year and mentioned on this page in our issues for September and November 1935.

With a program that stresses education as an effective means to the desired end, the Institute has actively taken up the cudgels of American sportsmen and has achieved in a short time a remarkable degree of success. It cannot be gainsaid that organization of interested groups, so that their combined voice will be far stronger than their individual voices, is an admirable method of swaying public opinion—and thereby, legislative opinion—in the proper direction. This is now being accomplished through the formation of the General Wildlife Federation by the Institute. The Federation looks toward the eventual bringing together of thousands of scattered sportsmen's clubs into state federations, these to form parts of the national group, all working toward a common end. With such an organization functioning properly it will be possible to exert influence both locally and nationally for the best interests of all.

The aims of the Institute are sufficiently broad in scope to embrace the problem of wildlife conservation in all its aspects. Already there has been held a conference of representatives from the United States, Canada, and Mexico. Educational propaganda in the form of posters, motion pictures, and lectures has been released with admirable results.

The conservationists face a hard battle, but, in contrast to the spasmodic efforts that have been exerted in the past, the present efforts are being directed on a scientific and business-like basis. In no small measure is Jay N. ("Ding") Darling responsible for the success to date. He has been one of the guiding spirits of the Institute and the Federation. Surely he deserves the support of every sportsman and nature lover who can see far enough into the future to realize that, unless vigorous action is taken, wildlife on the North American continent is doomed to follow in the steps of the dodo.

THE ROAD TO EMPIRE—II

Excavating the Sacred Well of Minturnae, and the Peculiar Surprise that was Found in it . . . What to do After Lightning has Struck a Public Building

By JOTHAM JOHNSON
University Museum, Philadelphia

(In our June number, Dr. Johnson described the early results of the excavations at Minturnae, Italy, which he directed for the University Museum of Philadelphia. He here tells more minutely of one of the monuments discovered by his expedition.)

DURING our first week at Minturnae we discovered the early forum of the city and the Appian Way (though it was to be weeks before we recognized them) and began isolating a building which we called Temple *A*. On its west flank we were held up by a truncated cone of concrete (Figure 1) six feet in diameter.

It looked like the base of some monstrous column. Starting from a simple moulding at ground level, a smooth stuccoed shaft rose four feet, breaking off abruptly. It stood so close to Temple *A* that a few inches of its base had been cut away to make room for the latter's ground course. Therefore—and this was important—it was older than the temple.

Figure 1: **A truncated cone of concrete which was at first a puzzle**

I was unimpressed and impatient to go on. Fortunately my inspector, Ernesto Tarabbo, enjoyed parallel powers of initiative as well as unlimited powers of veto. He found a comfortable perch up top of Temple *A* and off and on for two days I saw him sitting there in puzzled dejection. I was mystified, too, but ashamed to display it so openly. So it was Tarabbo and not I who eventually climbed down, scratched a circle in the rough top of the ruin, and called Alessandro to dig within. It had occurred to him that it might be a well.

The first objects to come out were neither significant nor exhilarating: field stones, potsherds, a broken marble decoration, loose dirt, then a dreary marble statuette without head, arms or feet.

As the hole deepened Alessandro lay on his stomach scooping out sand with a pointing trowel until we grew weary of his leisurely progress and thrust him down the shaft. It was just wide enough for his shoulders.

So far, the finds had all belonged to the late Empire. But, beginning about four feet down, the shaft of the well had been tightly packed with broken terracotta roof tiles and tile covers—and other things.

It contained little dirt, and with Alessandro handing the tiles up, progress became rapid. Without warning, the Victory (Figure 2) appeared. She was perfectly clean except for a little damp sand which easily brushed off. We set her up, admired her, and photographed her. Some of the original paint—gay red and blue, white and black—stuck to her. She was an acroterion from some small temple. We judged her to belong to the 3rd Century B.C. At one jump we had spanned four or five centuries and were back in the middle period of the Roman Republic, where we had wanted to be all the time. The well's stock began to climb.

Tarabbo nudged my elbow. Alessandro had just passed up a battered stone, once part of an altar. On two surfaces, still preserved, were traces of letters; I made out GVR and around the corner FVLG. Months later I realized that these were part of the words AVGVR FVLGVRALIS, 'priest of lightning'; I have no idea what the rest of the text said.

Photo by W. H. Witte

Figure 2: **We found an acroterion representing a winged victory**

I took Alessandro's place for a moment. Inside it was fairly roomy, but dark; the blue disk of sky gave less light than you'd think. I presently found myself standing on the upper edges of more roof tiles packed vertically. The inside surface of the well was not stuccoed.

I climbed out again. It was five o'clock. Tarabbo went down for a brief look and then we carried the marbles, the Victory, and the inscription to the storeroom and knocked off, leaving Pasquale, the night watchman, to guard the well with his life.

Next day we went on. Alessandro spent the morning passing up roof tiles, varied now and then by a pailful of wet sand and once by the crumbling bones of some sheep. Soon after lunch he reported that the shaft was blocked by a round stone. We hauled him out and I went down. True enough, a column

Figure 3: **"Dug down outside and cut a hole in the foundations"**

drum filled the shaft, except for a hand's breadth on each side. It was inches wider than the mouth; it could not have been lowered into the completed well. Therefore it must have been placed before the well was finished. I pinched myself.

I reached my arm down between the drum and the masonry. Below the drum I felt a bulging, curved surface like the echinus, or cushion, of a Doric capital, upside down. This completely filled the shaft. The well had clearly been built up after these objects had been laid in place. It could never have been intended to hold water.

We called it the Sacred Well. Other things claimed our attention, but we looked forward to finishing the job. Only heaven knew what primitive treasure might lie beneath those heavy stones.

In the spring Maestro Esposito was lent to us from the Naples Museum. He dug down outside the sacred well, cut a hole in its foundations (Figure 3), found two capitals (Tuscan instead

Figure 4: **Found two capitals, but the odd finds were still a puzzle**

of Doric) instead of one, hoisted them all out and lined them up nearby.

He also found two coins; one of Domitian, Emperor toward the end of the 1st Century A.D., the other of Maxentius who was ruling in 300 A.D. The latter was found *under* the lower capital. Inasmuch as the capitals had been buried about 40 B.C. and never again disturbed, the coins called for explanations. Probably they were loose in the top fill and slipped down ahead of us as we worked, one even reaching the mud at the very bottom.

This was one of the least of our worries. Esposito had found that the lowest 30 inches of the foundations were not conical but square, like a lidless box. He and one Giuseppe set to work on this with mallets and stone chisels, to enlarge the hole they had started higher up. We expected nothing exciting from the masonry, but the sacred well was not yet exhausted. The 'stones' imbedded in the sandy grey mortar proved to be fragments of terracotta temple decoration, of the same date as the Victory.

The operations were not completely uneventful, for the well threatened to collapse and we had to build a heavy cradle to hold it (Figure 5). Then we broke down the three sides we could reach, recovering more than a hundred terracotta fragments, still brightly colored. The mystery deepened further when we found that, instead of sporadic unrelated pieces, we could assemble them into almost complete plaques (Figure 6). There were enough types for two buildings. Assuming that the missing fragments are in the inaccessible fourth side, it is clear that the builders of the sacred well, in devotion to some precept of unrecorded ancient ritual, had gathered new, unbroken units and deliberately smashed them to include in the masonry.

I promised myself a week in a Rome library to read about wells. But before I could get away, the Gordian knot was cut by the Senator from Minturno, who appeared at the dig with a reprint from an Italian review in which dozens of obscure ancient references had been pieced together to describe a 'bidental.' Boiled down: When lightning struck a public building the citizenry, through their religious agents the haruspices, were at once concerned to purify the places struck and to offer an expiatory sacrifice to the author of the untoward omen, hoping to repair the past effects of the lightning and conjure away future effects.

THE priests gathered up the material traces of the celestial fire, the remains of the objects struck; they sought also to find the thunderbolts into which old superstitions held that spent lightning was transformed. They then dug a pit in a clean patch of turf and, singing funeral hymns, buried the lot. In this way the lightning was thought to have been buried and made harmless. Then they sacrificed a pair of two-year-old sheep (*bidentes;* thus the well was called a 'bidental'). When this tomb

Figure 5: **The weakened mystery well had to be shored up below**

Figure 6: **Plaques which began to provide hints of coming solution**

had been enclosed within a high wall, to hide it from human eyes and protect it from outrage, the ritual was complete.

Except for the thunderbolts (!) this was a fair description of the Minturnae monument: a well-like structure containing architectural units of two destroyed buildings (conspicuous 'remains of the objects struck') and the bones from a sacrifice. Then it was easy to identify the foundations of a wall built to hide the well from view. Finally we recognized the two buildings involved: the capitolium (capitals and one set of terracottas) and the stoa (column drum and other terracottas) which together had constituted the forum of Republican Minturnae. The Victory, too small for capitolium or stoa, came from some third building outside the forum, and implies widespread destruction.

We can now go back to the beginning and reconstruct a short, separate chapter of Minturnae's history.

Lightning struck the forum about the end of the Republic, and capitolium and stoa were burned to the ground. The Minturnese set earnestly about constructing the expiatory bidental we found. Beside the shell of the Capitolium they dug a square pit and lined it with low masonry walls, incorporating sample terracottas. Into this coffin they lowered the capitals and the drum. Then they built up the conical lining of the well, balanced precariously, as we found, on the middle points of the four walls. When it was finished they sacrificed two sheep, and filled the well with roof-tiles, the Victory, and a fragment of an altar set up by an augur fulguralis 150 years before. Around it they built a wall and called the job done. Later, Temple *A* took the protective place of the wall on the east. In the course of centuries two coins made their way in, but otherwise the well was not molested until the death of the city.

SCIENCE AT THE

How Special Agents of the Federal Bureau of Investigation Operate . . . Photography . . . Blood Tests . . . Preservation of Evidence . . . Moulage

OSCAR is dead. He was found murdered in his own room. Clues that might lead to the solution of the crime were not lacking but they could be found only after careful examination by trained observers. The secret of this "mystery drama" is that Oscar is a dummy used in the training school for Special Agents of the Federal Bureau of Investigation, Washington, D. C. After the scene has been set, students of the school are required to conduct examinations of the room and report their results which are graded in accordance with their skill in discovering, recording, evaluating, and preserving the evidence found. The importance of this work at the scene of a crime cannot be over-emphasized because it is here, many times, that evidence is found directing clues to the solution of a case. For this reason, the Special Agents are given thorough training in this phase of their work.

Upon arriving at the scene of the crime, it is incumbent upon the investigator to see that nothing in the vicinity is touched, if possible, until a complete examination has been made. Special Agents of the FBI are provided with equipment to be used in this examination, enabling them to obtain the evidence and to record accurately the facts to which they may be called upon later to testify in court.

It is often of the greatest value to have a photographic reproduction of the scene. Each field office of the FBI is provided with cameras of the latest type, which do not require an expert photographer to operate and which can be used with equally satisfactory results for indoor and outdoor pictures. One of the cameras used in the field offices is provided with a double extension bellows in order that it may be placed close enough to the object to take a full size picture. It can be used to photograph a handwritten signature or a fingerprint and in these types of pictures a one inch scale is included. In all work where the double extension bellows is used, focusing is done by use of the camera's ground glass back. This method of focusing is particularly helpful in taking portraits. The camera is equipped with an automatic shutter, giving accurately timed exposures of one-half and one second, which is of great value in copying and making close-up photographs. On the other hand, in outdoor scenes, where motion occurs, exposures as short as 1/250 of a second can be made.

Notes are taken, in connection with the photographs, recording the exact position and condition of objects at the time of the examination and, whenever possible, data are obtained concerning their normal appearance and condition. Exact measurements, taken by use of a tape measure or other measuring device, are used to make diagrams on cross-section paper. A compass is frequently used in connection with the preparation of drawings and diagrams to insure absolute accuracy.

Photo courtesy Franklin Institute

Shield (top) and kit of tools used by Special Agents in certain phases of their crime work

Oscar is dead! Students of the Training School, Federal Bureau of Investigation, collect and record all the evidence found at the scene of a hypothetical crime

After the general survey has been made, the examination of the crime scene proceeds in an orderly fashion. Extreme care must be exercised that nothing is overlooked. The magnifying glass, which is part of the Special Agents' equipment, can be used to examine articles for latent evidence. The Agents always keep in mind the fact that any article at the scene of a crime may be capable of giving evidence leading to the solution of the case. It is of the utmost importance that any article found which, in the opinion of the investigator should be forwarded to the Technical Laboratory of the FBI at Washington for analysis, should be carefully handled and packed for transmission. Documents, such as letters, telegrams, papers, and so on, are placed in Cellophane envelopes to protect the latent evidence which may be developed in the laboratory. Any dust particles or like substances requiring laboratory analysis are packed in small boxes. Chemically clean vials protect liquid

SCENE OF CRIME

By J. EDGAR HOOVER
Director, Federal Bureau of Investigation

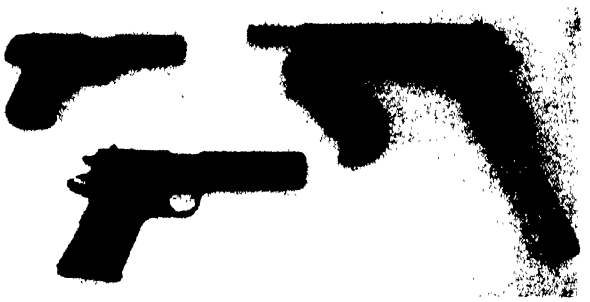
evidence. Labels reading "Do Not Open, Evidence For The Laboratory" seal this evidence. The Special Agent who procured the evidence then places the date and his initials on the seal. When original evidence is received in Washington, it is opened in the laboratory and the envelope or box in which it was sent is filed, after being initialed by the person who received it. Thus a chain of custody is established in the event the evidence becomes of value in the case.

It may be necessary to determine the nature of stains that appear on some substances at the scene of a crime. The benzidine test for the presence of blood is used by Special Agents in the field as an investigative procedure to select stains for further laboratory examination. In the presence of blood a blue or greenish color is produced by application of this solution, which is sensitive to one part in 300,000 and will detect very old stains as well as fresh blood.

The first step in making the benzidine test in the field is the removal of a small portion of the stain from the substance to which it adheres. This can be done by chipping off a small part of the stain with a knife. This substance is then placed on a chemically clean piece of white blotting paper. A physiological salt solution is then dropped from an eye dropper on the stain, causing it to dissolve. The benzidine reagent is then applied to the blotter and the color, if the stain is blood, changes to blue. In order to be sure that the test is being correctly performed, a control test is carried out by placing the salt solution on another piece of blotting paper and applying the benzidine reagent. The control test, of course, shows no color.

THE benzidine solution is prepared by placing a few crystals of recrystallized benzidine in the bottom of a test tube and adding grain alcohol until the benzidine just dissolves. By this means a saturated solution is prepared. Two or three drops of glacial acetic acid are then added and the solution is well shaken. After two or three drops of hydrogen peroxide are added, the entire solution is again shaken. The solution should be used immediately and must be prepared fresh for the examination. The physiological salt solution is prepared by dissolving common salt in distilled water. The strength is .85 percent, which is approximately one fourth of a teaspoonful of salt in one cup of distilled water.

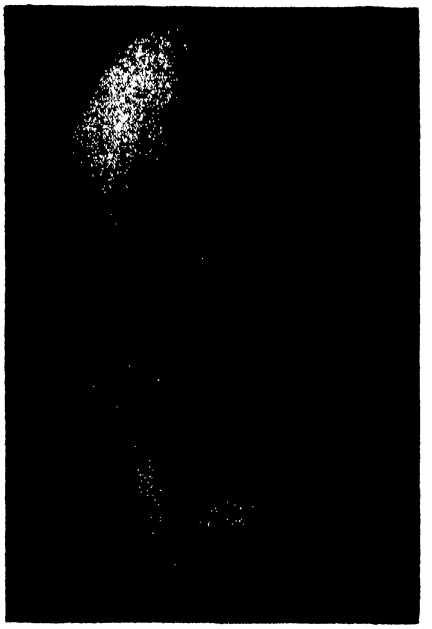
The positions of stains which prove to be blood are evidence of the action which caused them. The spattering of drops indicates the direction from which they fell and the force with which they were projected onto the surface upon which they were found. Drops of blood from a wounded person who is walking will usually be pear-shaped, the smaller end pointing toward the direction in which the person was going. Round drops are found when there is no movement of the wound. If the wound is on a person's hand, when he swings his arm backwards some of the blood will be thrown away from the direction in which he is walking, and the smaller end of the drop will be pointed away from the direction in which he was going.



Moulage reproductions of guns

In addition to the position, the condition of the substance believed to be blood is important. The amount of coagulation or clotting helps in determining the length of time which has elapsed. Normally, human blood begins to clot in two or three minutes and completes the process in seven to nine minutes. Variations in conditions surrounding the blood cause the time of coagulation to vary in each case, but the absence of coagulation indicates the lapse of a very short interval.

The drying of blood is another factor, independent of coagulation, which is utilized to estimate the age of a stain. From one to two hours is required for a single drop of blood to become dry, while larger amounts dry much more slowly.

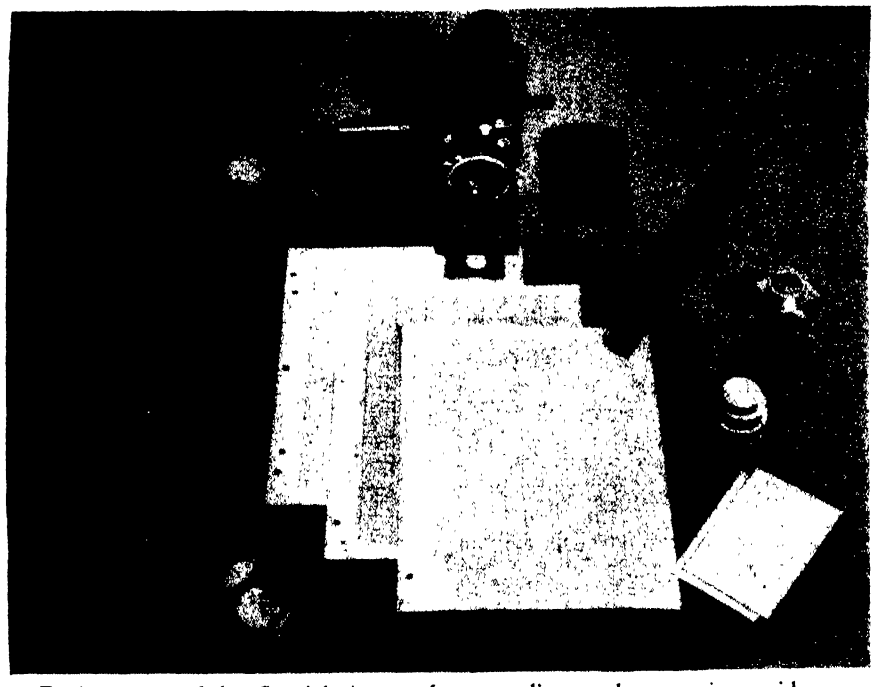


Moulage death mask, made by the process described in the accompanying article. Note preservation of minute details in skin and hair

The color of stains is important. In a fresh stain, blood has a bright scarlet color. Upon exposure this gradually changes first to brown, then dark brown, and finally almost black. The variation of conditions affects the rapidity with which the change of color occurs; however, from the color of a blood stain, a fair conclusion may sometimes be drawn as to its age. Under certain conditions, blood may be violet, green, yellow, or other shades, and the investigator should not overlook the possibility that a stain showing such shades may be a blood stain.

VERY often, at the scene of a crime, evidence of a perishable nature may be found. By the use of moulage, the invention of Dr. Alphonse Poller, Viennese scientist, reproductions of such evidence generally can be made with absolute accuracy of detail. While photography is of the greatest value in recording and preserving perishable evidence, it fails to reproduce the third dimension of objects, and often that detail is necessary to make identification. Moulage is particularly useful in showing the shape of wounds existing on the body after death, in reproducing facial features permanently for identification, and in preserving impressions made upon perishable objects, such as tooth marks in an apple and impressions in sand, dust, or mud.

The application of the moulage process does not require any great amount of training or any particular technique. Commendable work can be turned out



Equipment used by Special Agents for recording and preserving evidence gleaned at the scene of a crime. Accurate scale drawings are frequently made

by anyone with a little practice. The actual process consists of the making of a negative mould and a positive cast. The material for the negative is a colloidal preparation while the material used in the positive cast is a resinous wax. They both require heating before being applied. After being heated, the negative material is applied to the object with a brush or spatula. The negative hardens upon drying and is easily separated from the object. The heated positive material is then poured into the negative mould and allowed to cool. When that hardening process is finished, the negative mould is peeled, cut away, or slipped off the positive form and the particular piece of work is completed, giving a reproduction of the object in its finest detail of form and texture.

MOULAGE material may be transported from the place where it was prepared to the scene of a crime in vacuum bottles or jugs, as the occasion requires. The reproduction can be made while the object remains in its original position, if desired, and without any difficulty or elaborate preparation.

Where minute detail is unnecessary in the reproduction of evidence which may perish or be destroyed, plaster of Paris casts may be made. This method is excellent for the reproduction of footprints and tire tread impressions in the earth or snow. The material is quickly and easily made by mixing finely powdered plaster of Paris in water. This mixture should be free of lumps and air bubbles; care should be taken in pouring the mixture upon the object to be copied so as not to disturb its shape. The mixture is then permitted to harden, requiring about 20 minutes, being strengthened by imbedding sticks, wire or other stiff materials, and is then removed. By spraying a thin coating of oil on the earthen mould, the sticking of earth to the plaster is prevented. Snow should be thinly coated with talcum powder before the mixture is poured.

The Federal Bureau of Investigation maintains a file of approximately 1800 specimens of tire patterns, covering tire models manufactured by both Canadian and American tire manufacturers, rebuilders, and remoulders. When a plaster of Paris or moulage cast of a tire tread found at the scene of the crime is forwarded to the Technical Laboratory, it is compared with the designs on file. By use of this file, the type of tire used by an automobile at the scene of the crime can be definitely known. Later, when an automobile is recovered which may have been used in connection with the crime, specimens of tire tracks from all parts of the tire's surface can be obtained and matched with the tracks found at the scene of the crime.

DAILY, at the Technical Laboratory of the FBI, experiments are being carried on by technicians in an effort to provide the investigator in the field with new scientific equipment and to augment the use of existing equipment. Special Agents in the field are kept advised concerning the progress of this work and each month the entire investigative personnel of each field office is required to attend a conference at which new developments and new methods of scientific approach to the problems of a case are discussed. Without a scientific approach in the field, science in the Crime Laboratory would be materially hampered. The interdependence of these two phases of criminal investigation is kept uppermost in the mind of the investigator as he conducts his examination at the scene of the crime.

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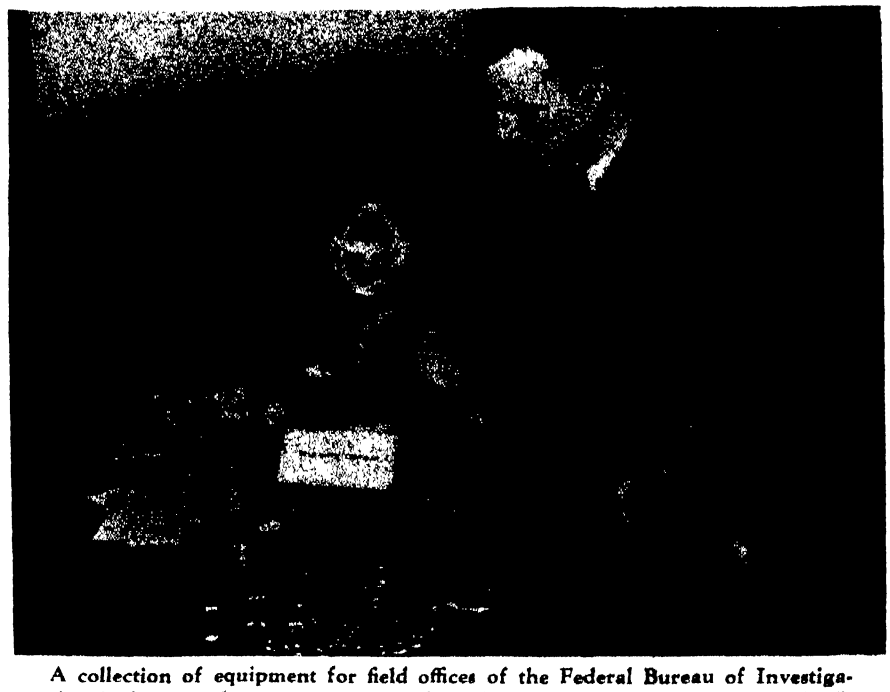
EDITOR'S NOTE: *The admirable record of the Department of Justice in cleaning up kidnapping cases under the Lindbergh Law is disclosed by a recent Associated Press dispatch. All "public enemy" kidnapping cases under the jurisdiction of the Department have been solved, resulting in the conviction of 146 persons in 63 kidnappings. Twenty-nine of these went to jail for life; sentences of all totaled 2028 years.*



A collection of equipment for field offices of the Federal Bureau of Investigation includes such items as tools, lights, binoculars, and, of course, handcuffs

High Efficiency From New Lamps

Rainbow Colors . . . Sun-Like Brilliancy . . . Still in Laboratory Stage . . . May Open Vast New Fields

A POSSIBLE revolution in lighting practice may be approaching as a result of developmental work now in progress on two new forms of mercury lamps known as fluorescent and capillary types. The first appears to have great potentialities in providing a wide range of remarkable colored lighting effects; the second of relatively small dimensions—produces, in some cases, a brilliance exceeding that of the sun and emits a wealth of photo-chemical rays useful in commercial, industrial, and therapeutic applications. Since the lamps are still in the laboratory stage of development, it has not yet been determined whether they will eventually be used in combination with conventional incandescent lamps or as separate units.

Initial development of the capillary lamp was done by the Philips Glow Lamp Works of Eindhoven, Holland, and subsequent American research at the Lamp Development Laboratory of the General Electric Company, Nela Park.

For the electric energy used, the fluorescent lamps will give from 50 to 200 times as much colored light as do ordinary colored incandescent lamps, and in addition produce a quality of color far superior. Within the bulb is a trace of mercury, a small amount of argon gas at low pressure, and a special fluorescent powder which clings to the inner surface of the glass.

WHEN the lamp is turned on, the argon serves as a "starter," and in a few moments a feeble, blue light and a large amount of invisible ultra-violet radiation is generated. The invisible ultra-violet radiation strikes the fluorescent coating and is transformed into visible radiation of colored light, the various colors being produced by powders of different chemical composition. In this transformation of invisible ultra-violet radiation into visible radiation lies the great gain in efficiency over the present use of colored incandescent lamps.

It is expected that the new fluorescent lamps will be widely used in homes, theater lobbies, supper clubs, hotels, stores—in fact, wherever colored light can serve as decorator and scene painter.

The new capillary lamps, which are of both air- and water-cooled types, can be made to emit about three and one half times as much light, for the electric energy consumed, as the average incandescent lamp. They derive their name

Two of the fused quartz capillary lamps. At right is the water-cooled type; at the left, air-cooled

from the tiny tube or bore in each lamp. In the tiniest capillary lamp, the bore is so small that it will hardly accommodate a common pin. It is in this tiny "tunnel" that extremely high pressure can be developed. Like other mercury lamps, the capillary lamps require special equipment for starting and operation and need several minutes to arrive at full brilliancy.

Four laboratory specimens of the new fluorescent mercury lamps. In the foreground is a sample of the fluorescent powder used in them

Water-cooled capillary lamps—only an inch long and one eighth of an inch in diameter—will supply as much light as the conventional 1000-watt filament lamp. It has been found that by raising the pressure within the lamps, the production of red rays is increased to such an extent that it is possible to obtain about as much red from these tiny lamps as exists in sunlight. At the highest pressures yet attained in the laboratory—equivalent to several tons per square inch—the brightness of the light produced exceeds that of the sun. Under very high pressures, however, the lamps are likely to break from excessive heat, hence the need of a jacket containing cooling water.

The light from the air-cooled capillary lamps, being rather deficient in red rays, is unsuited for uses where color discrimination is important. It is possible, however, to place the air-cooled lamps within bulbs inner-coated with fluorescent powder, and early experiments in this connection indicate a considerable improvement thereby in color quality. This may eventually result in light of a quality akin to daylight. The air-cooled lamps, in their present form, are about two inches long and three eighths of an inch in diameter—yet they produce light equivalent to that of a 200-watt incandescent lamp which is about 8 inches long and 3½ inches in diameter.

IT is expected that capillary lamps will find ready application in a host of fields. For example, the air-cooled lamps, inside of bulbs inner-coated with fluorescent powder, should be "naturals" wherever a higher quality and quantity of work-light is wanted. Within clear bulbs of special glass, these lamps deliver beneficial ultra-violet in such abundant amounts as to hold great promise in the therapeutic and photographic fields.

Water-cooled capillary lamps, because they produce photo-chemical rays, sun-like brilliance, and are relatively small in size, hold great promise for application in highly specialized fields. The future will probably see these lamps used in blueprinting; in motion picture production and projection equipments; in air beacons and searchlighting units; and possibly in street, highway, store, and factory fields.

ARE WE INSIDE A DARK NEBULA?

Recent Investigations Suggest that Our Part of Space is Slightly Hazy, and Provide a Hypothesis of the Origin of the Sun's Family of Comets

By HENRY NORRIS RUSSELL, Ph. D.

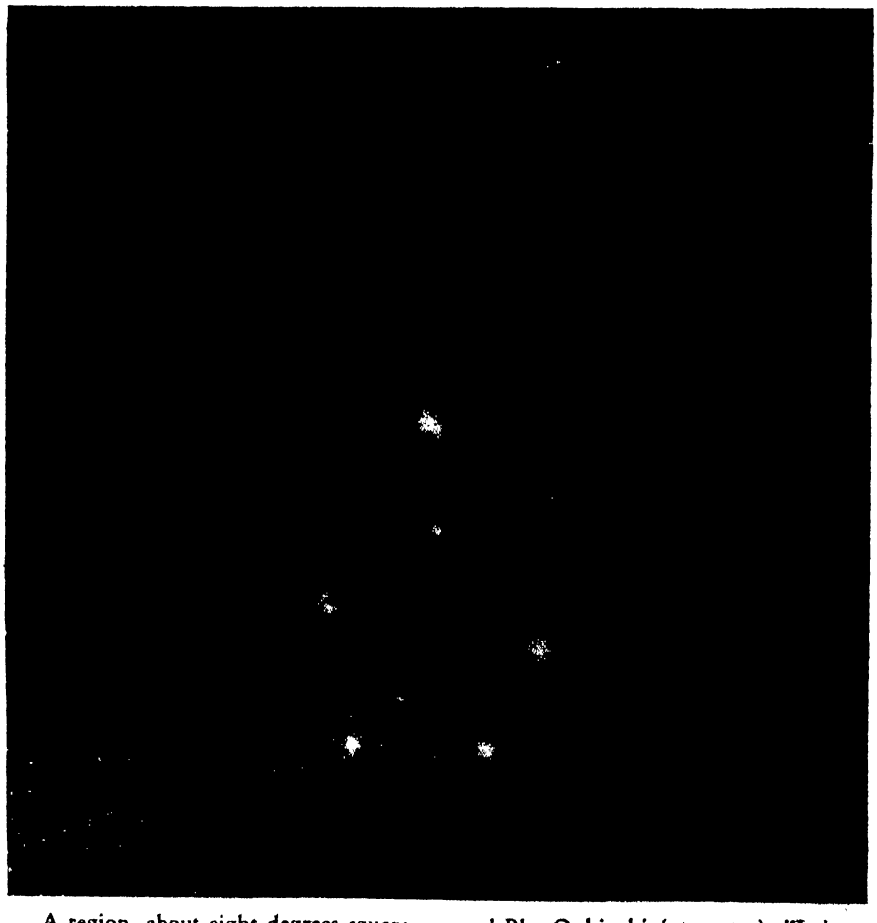
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society.

EVERYONE familiar with astronomical photographs is acquainted with the dark nebulae—those enormous foggy or dusty regions of space which appear here and there against the starry background of the Milky Way. Some of them are readily visible to the unaided eye—notably one in Cygnus, which crosses the Galaxy transversely, and other great irregular regions in Ophiuchus and Scorpio, above Antares. The most prominent of all, close to the Southern Cross, has been known for centuries to mariners by the name of Coal-Sack.

A first glance at the photograph suggests that the denser of these clouds are entirely opaque. But careful counts of the numbers of stars in equal regions of the sky within the obscured regions and outside show that this is not the case. The stars behind show through, but with brightness diminished to a quarter or even a tenth of the original intensity.

Compared with these cosmic clouds, an ordinary terrestrial fog seems like a solid wall; it cuts off more light in a hundred yards' thickness than a dark nebula does in a light-year. Indeed, the clearest and most pellucid air is opaque compared with them. The hundred or two of miles which the rays of the setting sun traverse suffice to reduce its light to less than one percent of what we get at high noon.

The Coal-Sack, which obscures a smaller proportion of the light, and is many parsecs in thickness, must be many thousand millions of times more transparent than the purest air—or else correspondingly thinner than the air we breathe. The whole solar system might be immersed in such a cloud, without diminishing the light of the remotest planet by an amount which our most delicate photometric apparatus could measure.



A region, about eight degrees square, around Rho Ophiuchi (at center). "It is clear," Barnard says, "from an inspection of the picture, that the actual background of the sky here consists of a uniform distribution of stars." On this background are seen one large and several small lanes of dark nebulosity extending to the left. These dark irregular cloud regions are mentioned by Professor Russell in his opening paragraph and their distance is approximately 400 light-years

THE light of the stars, which shows through the cloud from outside, would be perceptibly weakened; but if we were near the middle of a uniform ball of thin haze, the stars all over the sky would be affected to about the same degree, and it would be hard to find this out. If, however, we were near the edge of the cloud, so that it looked much thicker on our side of the heavens than the other, we should see more stars on the clear side than in the opposite direction. But then we would have to make sure that there were not really more stars there—which would not be easy.

Go still further: Suppose that the fog, though very thin, extended so far that all the nearer stars were included within it: Could we detect it then, even if it was lop-sided? An interesting paper by De Corlin of Lund in Sweden attempts an answer.

The parallaxes and distances of thousands of stars have been observed, by the direct trigonometric method, using essentially the surveyor's geometrical principles, and also spectroscopically—finding from the intensities of certain lines in the spectrum how bright a star really is, observing how bright it looks, and then calculating the distance. Thin fog in interstellar space will not affect the first method at all—so long as we can see the star. But it will vitiate the results of the second, for the calculations are made on the assumption that space is clear, and the faintness of a star due only to its distance. Obscuration of light will make the stars look fainter, and our calculations will put them too

far off. If the fog is thicker on one side of the heavens than the other, the distances of the stars on that side, determined from their spectra, will therefore be too great. On the clear side they will be too small—since the spectroscopic calculations are adjusted so as to make the average for the whole sky come out the same as by the more direct method.

In the great catalogue of parallaxes, recently published by the Yale Observatory under Dr. Schlesinger's direction, there are some 1100 stars whose distances have been determined by both methods. De Corlin, studying these results, and grouping the stars in different regions of the heavens, finds that, on the average, the spectroscopic method puts the stars in the southern heavens (Scorpio, Centaurus, the Southern Cross) rather farther away than do the direct measures of the same objects, while in the opposite region (from Cygnus to Andromeda) the reverse is the case.

This suggests that our part of space is indeed slightly hazy, thickening toward the first-mentioned direction, and thinning toward the other. The haze appears to thicken on the side toward the center of the Galaxy.

THIS result, if confirmed by other methods of study, as its author recommends that it should be, will be of great general interest. It may be noted, however, that the degree of fogginess which De Corlin derives is very small indeed—far less than in such dense obscuring clouds as the Coal-Sack—and that it changes very gradually. The maximum difference in absorption of light which he finds, between stars 50 parsecs (160 light-years) away, in opposite directions, amounts only to a fraction of a stellar magnitude, while on the edges of the best-known dark nebulae, a similar change happens in something like a thousandth part of the distance. Small as this change is, it cannot keep on much farther than is indicated by his investigations (which were deliberately limited to the near stars, and for sound reasons), for in the region where he finds the haziness to be increasing, we observe the magnificent star-clouds of the southern heavens, while the opposite side of the Milky Way is much less brilliant. But there is nothing impossible, or even improbable, about this.

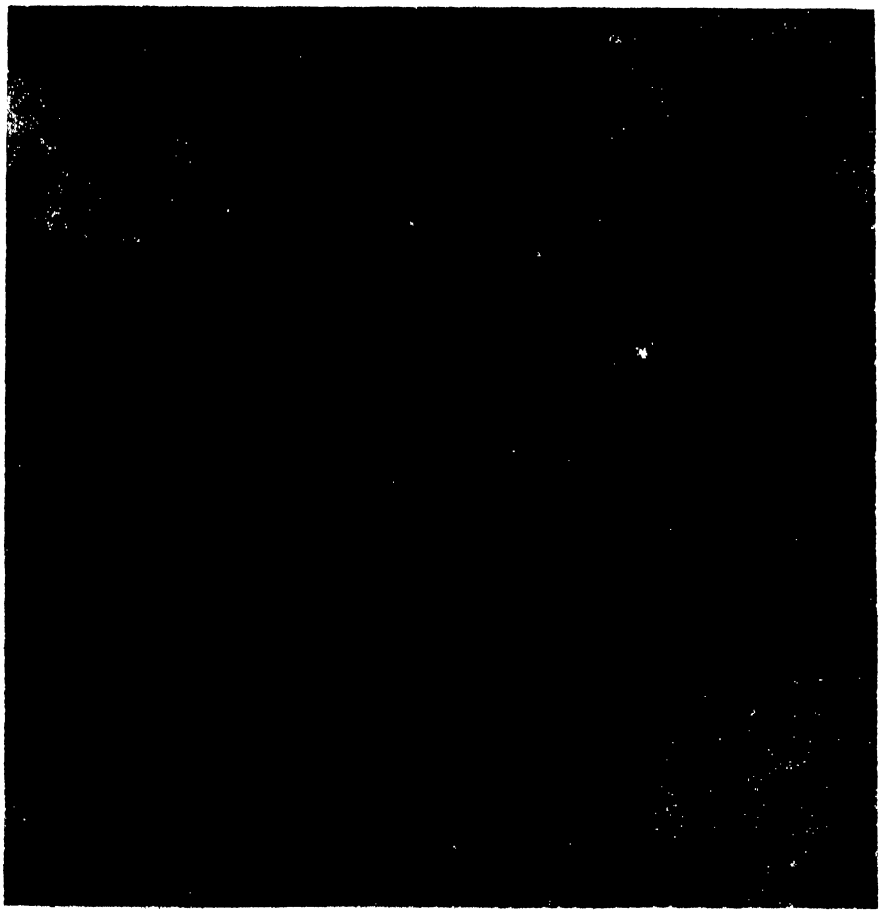
If we are really in a nebulous region of space, some astronomical problems apparently quite unconnected with the original problem may be solved—in particular, the old and difficult one: Where did the comets originate?

Both comets and planets belong to our system—they share the sun's motion among the stars; But in all other respects they are so different as to justify fully the late Professor Chamberlin's description of them as "the two solar families." Comets are swarms of particles of very low average density: They do not move in almost circular orbits, like the planets, nor approximately in one plane; instead, they move in highly elongated orbits, which extend to great distances from the sun, in all directions indiscriminately. Moreover, planets are obviously long-lived and permanent members of our system, and comets as clearly are not—they are subject to many changes. A comet which passes near a planet may be speeded up by its attraction and sent off into space in a hyperbolic orbit, never to return.

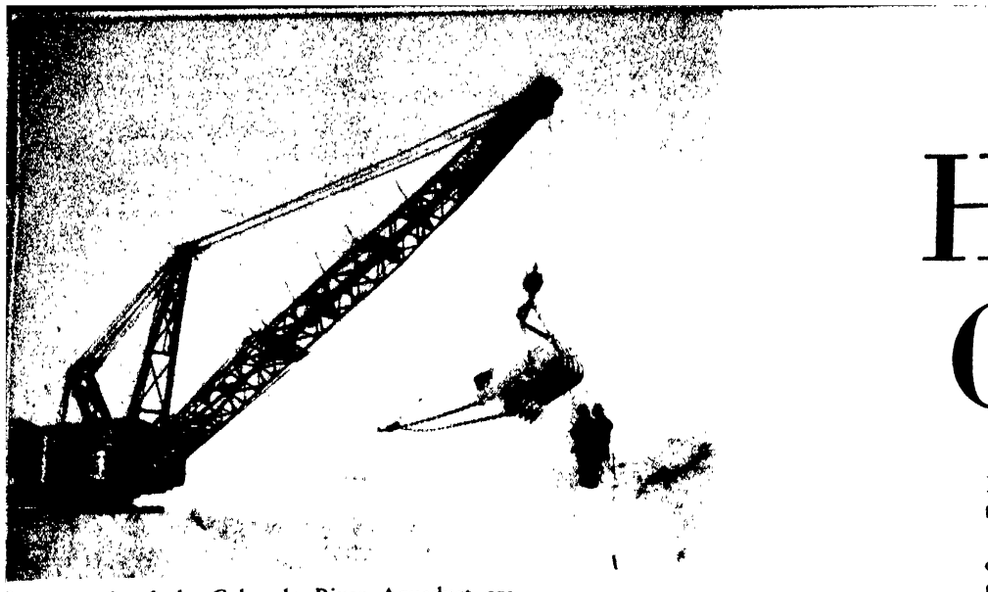
If it avoids this fate, but moves in a long ellipse with a period of tens or hundreds of thousands of years, the attraction of the nearer stars, though far too small to prevent its return, may shift its orbit so that, when it does come back, it will be too far from the sun to shine brightly enough for us to see. If, on the contrary, it comes near enough to the sun to be stirred up to grow a fine long tail and appear as a brilliant object, it will lose, in this very process, a part of its own substance, which flies down the tail, driven by radiation pressure, and is lost in the depths of space.

Between the chances of being driven out of our system, and the slower, but sure, probability of ultimately wearing out, it is hard to see how any comet can have kept circulating about the sun, and shining for anything like the past duration of our system. The suggestion has often been made that the comets are late-comers compared with the planets and, in particular, that at some time in the not very remote past (cosmogonically or geologically speaking) the sun passed through a nebula, and carried off bits of it, which were left moving about it in elongated orbits.

There are difficulties here too, but if we assume that the nebula in question was very rich in isolated swarms of particles, such as comets appear to be, the hypothesis may be tenable. The vast majority of these swarms would pass round the sun in hyperbolic orbits and be lost; but some might be diverted by the action of the planets into ellipses and return again and again. Those which came back most rarely would last longest, which may help to explain the existing preference for long periods. It is still hard to explain why the distant ends of the orbits show no notable preference for any direction in space; and we do not know whether or not the dark nebulae contain such swarms as has here been supposed. But there is at least room for speculation of a legitimate sort. —*Princeton, May 5, 1936.*



Another plate by Barnard, showing a dark nebulosity, two degrees by three, in the region of Theta Ophiuchi. "Whatever the material in the dark space may be," says Barnard, "it is evident that we are not looking out into space through an opening in the Milky Way." Both cuts are from the Barnard photographic atlas



Open canals of the Colorado River Aqueduct are first "roughed out" with giant drag-line shovels after which the sides and bottom are smoothed for paving

High-Speed California

By ANDREW R. BOONE

FINISHED smooth as glass by means of giant trimming and paving machines, 62 miles of canals in southern California are being "streamlined" in order that a billion gallons of Colorado River water may be supplied daily to Los Angeles through the 242-mile Metropolitan Water District aqueduct. [See also September and November, 1934, Scientific American.—*Editor.*]

The canals form only part of the huge 220,000,000-dollar undertaking. There are also 92 miles of tunnels, 55 miles of conduit, and 29 miles of siphons. By smoothing the water-contact surfaces of all these units, eliminating sharp curves, and abolishing all rough spots, the required volume of water can be carried in underground bores 16 feet in diameter, whereas it is estimated that 18-foot tunnels would be required were they left rough.

One of the most interesting mechanical developments used on this project is the canal trimming machine which, moving on rails, straddles the 60-foot ditch. After a section of the canal is "roughed out" by a drag-line shovel, the trimming machine smooths the sides and bottom. As it runs back and forth, a series of knives slice away thin sections of earth and an endless chain dumps the "shavings" out along the banks. Paving is accomplished in a single operation by means of giant machines which lay the concrete, spread it, and tamp it in place. The pavers are really rolling bridges supported at the ends on trucks which run on rails upon and paralleling the canal banks. Concrete, supplied by double-ended mixers rolling on Caterpillar treads, which can be loaded from trucks at both ends simultaneously, is dumped from the mixers on the canal bank into a motorized, bottom-dump hopper car which then runs across the

The canal smoothing machine travels on rails on the canal banks, shaving the sides and bottom. The removed material is discharged on both sides of the canal

Placing the re-inforcing steel on the canal bed, making ready for the high-speed concrete laying machine

The paving machine placing concrete on the re-inforcing steel. Operation of this giant paving machine is described in text

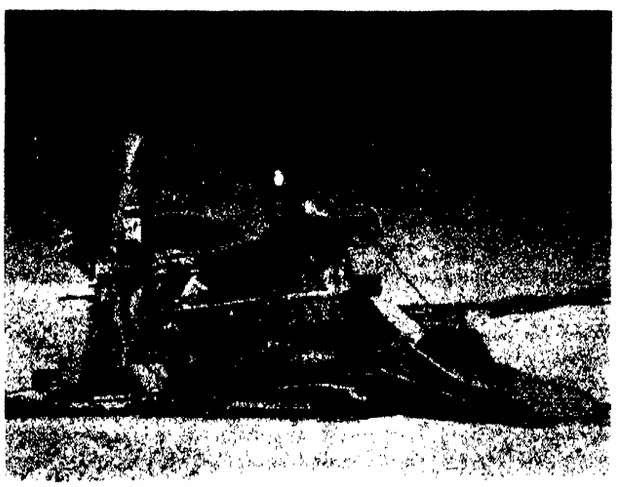
Paving For Aqueduct

Mixed concrete is loaded on the motorized dump hopper car (center background) and distributed to the working edge of the paving machine through the slot that leads to a series of small compartments

top of the paver, dumping the concrete down between the rails into a chute, and thence into small compartments provided to keep the plastic concrete from moving laterally down the slopes and piling up at the bottom. The hopper car makes one and one half trips a minute, distributing the concrete evenly. Ready to operate, the complete paver weighs in the neighborhood of 48 tons. These machines are moved by motor driven winches pulling against anchors on the rails or in the ditch ahead.

Formed to the shape of the finished canal and welded in place on the paver is a steel slip form for the finished surface of the concrete. In the leading edge is a tube in which an eccentric rod revolves rapidly, thereby vibrating the concrete as it is laid, packing it down, and at the same time producing a smooth finish. As the machine progresses, the finishers follow behind, and from framed wooden "jumbos," also mounted on the side rails, work over the surface of the concrete with hand trowels to produce the desired hard finish. At a speed of about one foot per minute, one of the machines will pave approximately 500 feet, placing over 700 yards of concrete in one eight-hour shift, whereas the abandoned hand-placing method could only account for a 200-foot advance, placing only 282 yards.

Within tunnels, conduits, and siphons, workmen grind down inequalities, particularly at joints, with high-speed emery wheels. Finally, the concrete is rubbed to a high lustre. Nowhere throughout the length of the winding aqueduct is there a sharp corner. Thus friction is reduced and water will flow with little restraint the entire width of the state of California—from Parker Dam to Los Angeles—through a series of tubes and canals containing 5,760,000 barrels of cement, or enough to build a highway 14 feet wide from San Francisco to New York. This is the world's biggest cement job, surpassing Boulder Dam by 170,000 barrels.



One of the double-end concrete mixers which may be loaded with materials at both ends simultaneously. The mixer advances on endless treads to keep pace with the concrete laying machine as it proceeds

Smoothing the inner surface of one of the conduits with an emery wheel to reduce resistance to water flow

A close-up view of the working edge of the paving machine, showing the concrete being applied to the re-inforcing steel. The mix is tamped automatically to a smooth surface

YOUR BRAIN

By G. H. ESTABROOKS
Professor of Psychology at Colgate University

I HAVE a friend who lost a great part of his brains during the World War. He was wounded in the head by a fragment of shell, which also destroyed large areas of grey matter. When he was sent to hospital the shattered bone was replaced with a silver plate and he eventually returned to the front, ending his career as a colonel of infantry. Obviously no great harm had been done. Another chap has a bullet in the front of his head and seems quite normal. One psychologist reports taking a tumor, the size of an orange, from the right side of a man's brain. He suffered no ill effects and had had very few symptoms up to the time of operation. A medical acquaintance tells of a case wherein syphilis had so destroyed the brain tissue that he was able to thrust a medical lance up through the nose into the brain and to within half an inch of the back of the head. The individual later died of the syphilis, but up to that time his main symptom had been dizziness.

In other words, it is astounding what damage one can do to the brain with little or no result. One authority says that the most remarkable thing about the human body is how much it can stand—and how little it can stand. For the reverse is also true of the brain, as of all parts of the body. The slightest pressure on the vagus nerve, which controls the heart, may cause instant death. A tumor the size of a pea, on the pituitary gland in the head, may result in blindness, while those of us who went through the last war recall numerous cases of men dead without a scratch on the body—just the result of air pressure from an exploding shell.

A knowledge of the way in which the nervous system works is essential if we would understand mental disorders. This can be made quite clear if we attack our problem from the practical end. Just what happens when something goes wrong in a specific place? For example, we divide the nervous system into three broad levels, the brain proper, the basal ganglia or structures at the base of the brain, and the spinal cord with its incoming and out-going nerves. Now suppose the syphilis germ invades the nervous system. Various things may happen because this particular bug is by no means choosey in his diet. He will attack bones, arteries, skin, or nervous tissue and, what is more, he may start work on any level of this nervous system. Let us suppose that he attacks only the spinal cord, or the lowest level. The result is a peculiar interference with walking or handling the arms. Locomotor ataxia, we call it and, if no complications result, the individual may be normal in all respects except that he walks with the peculiar shuffling gait characteristic of this disease.

But the syphilis may go up to the base of the brain. The symptoms will then be much more severe, seen largely in a lack of emotional control. The individual becomes subject to the most violent fits of temper, or outbursts of crying and laughing. Yet otherwise he is quite sane and can reason as clearly as ever. Only when the brain proper becomes involved do we get that terrible insanity known as general paresis.

Let us review this picture a little more carefully. Suppose your right leg is paralyzed. What is the cause? Like the devils in the herd of swine, the possible number of causes is legion. For example, it would be quite simple for any surgeon to paralyze that leg of yours by cutting the nerve anywhere between the spine and the muscle; but the nerve lies pretty deep and generally escapes ordinary accidents. Moreover, there aren't many germs that attack the nerve outside the spine.

WITHIN the spine, however, many things can happen. One of the most tragic is infantile paralysis. The germ of this disease is very select as to diet. It feeds only on the cell bodies of those nerves which go to the muscles. As a result the muscles, robbed of the nerves which control them, can do nothing and simply waste away. We have hopes that a serum, made from the spinal column of the monkey, can be prepared to check this pest but, so far, little can be said. Then spinal meningitis might be the cause of this paralysis. Here the germ attacks the coverings of the spine and these become inflamed, sometimes to such a degree that these coverings actually grow into the nerve cells and destroy them, causing all sorts of paralysis. Syphilis of the spine generally comes out as locomotor ataxia, already mentioned and more a disturbance of walking than an actual paralysis. Tumors of the spine are not infrequent and may cause paralysis of a limb, while the cord may also degenerate in pernicious anemia, giving a similar result. Of course a "broken back" or any serious injury to the spine might paralyze a leg, while the surgeon, when he uses a "spinal anaesthetic," produces the same result for the time being. These are a few of the commoner causes of paralysis.

All this is dependent on the fact that your leg movements are controlled from the brain, that the "lines of communication" go down your spine, and that any interference with these pathways will always cause trouble. But note that this has nothing to do with mental disease, despite the fact that nervous tissue is involved. In other words, you may have diseased nerve cells even, as we shall see, in the brain without having insanity and you may also have insanity without any brain injury at all. Destruction of nerve tissue at this lowest or spinal level can only cause interference with muscular movements. But note that "spinal" meningitis may spread to the brain, which is very serious; also that spinal syphilis may do the same, and that infantile paralysis may get to the base of the brain and cause death. This is a different story, to which we will now pass.

When the disease germ spreads its activities into the base of the brain it is quite another matter—and much more serious. Here, just under the brain proper, which consists of a large, wavy mass, are several structures which are very important. First are those nerves which control heart and lungs. That is the reason why "high" infantile paralysis always worries the doctor. When the face becomes paralyzed, it is a sign that the infection is getting very close to the lung and heart nerves, so he telegraphs for an "artificial lung," and prays for the best. A broken neck may be fatal for the same cause—which is the reason why the hangman is so very careful to arrange his knot so that the pressure will be just where it ought to be. He aims to please.

Then the lines of communication from brain to leg or arm muscles pass here on their way to the spine. So an infection in the brain base may give you "St. Vitus dance," paralysis or twitching in any part of the body, or that curious apathy that goes with "sleeping sickness" but which has nothing to do with sleep.

Finally the brain base has some curious association with emotions, and here we first cross the path of insanity. For example, suppose we have a syphilitic

How Much and How Little the Brain Can Stand . . . The Hangman Is Careful . . . Insanity . . . Delirium Tremens . . . Stroke . . . Opium Visions . . . Epilepsy . . . Dementia Praecox . . . Other Things that Happen to People's Brains, and What They Signify

infection in one of these structures, the optic thalamus. The individual shows a weird lack of emotional control. He will laugh for an hour with no cause whatsoever—and he doesn't feel funny. He feels like a fool but can do nothing about it. All his other emotions may be similarly "unstuck." This condition becomes much more serious in sleeping sickness, which is a disease of the brain base. In addition to his sleep the individual may develop an intense irritation which makes him a very dangerous person to have around. When in one of these fits he is likely to commit crimes which make ghastly reading.

From the base of the brain we move to our highest level, the brain proper. Here again disease may yield several results, only a few of which can be classed under the head of insanity. For example, just above your ear is the motor area of the brain, which controls all body movements. It is a fairly large section, so we can interfere with one part, yet not affect another. When your friend has a "stroke" it simply means that a blood vessel has burst in this area and has knocked out the brain cells controlling the arm, the leg, or other part. But note that while his brain is injured, he is by no means "insane."

ONE of our most fascinating chapters in psychology centers around this problem of brain localization. For example, just about under the bulge of your forehead is the learning center for delicate muscular movements. Here you learn to write, to play the piano, or to handle your knife and fork. Should you receive an injury in this area, such as that caused by syphilis, a bullet, or a bursting blood vessel, the result may show itself in the curious disease "apraxia." Here you lose all capacity for skilled movements. Asked to sign your signature, you find you have completely lost the ability to write. The best you can do is to seize the pencil in your fist and sign in letters a foot high. Given a knife and fork, your manners would shock a chimpanzee. One of the funniest exhibitions I ever saw was a soldier, wounded in this area, trying to pick up a cup by its handle. He finally ended by seizing it in both hands, pressing so hard that he broke the china completely—and he was as much amused at his clumsiness as were any of the observers.

Just about under your brow ridges is the "speech" center of the brain. It is here that you learn to talk, to handle your tongue and lips. Any interference with this section of the brain may give the condition called "motor aphasia." You literally forget how to use your speech apparatus. You know what you want to say but when you try to say it you talk gibberish, just as you may know what you want to play on the piano but be unable to do so, as in "apraxia." Both are actions involving high grade muscular coördination, and any trouble in the coördinator ruins the activity.

Then we have "auditory" aphasia, which is the same picture but upside down. This is also a disease of the language function but at the other end, as it were. The nerves from your ear go into the brain almost straight, and just back of the temple you have the association center for hearing, which means that you learn to understand language in this brain area; whereas you learn to speak it under your brow ridges. If any injury occurs in this section of the brain near the temple, the results are about what you might expect. You can no longer understand spoken language and even music may be meaningless. Should an individual talk to you in your native tongue, say English, it would literally be Chinese, so far as you are concerned. Yet you can read, for that is a matter of the eyes. The first case I mentioned in this article, when hit by the shell fragment, suffered an injury here. As a result he had to relearn English, and French, really his native tongue, was forgotten completely.

Another curious condition results from injuries to the back of the head. Here is where the nerves of vision finally end. Here also is the learning area for everything that comes in by the eyes. For example, suppose you have a tumor in this area, or a blood vessel bursts. You can no longer *read* English, because this is a matter of vision, and the learning areas have been wiped out. You can still understand everything that is spoken and can yourself speak with no difficulty, but even a flaming advertisement for your favorite cigarette on Times Square is beyond your reading capacity.

Some of our most interesting cases are those suffering from congenital cataract. Here the eyes are quite all right, but there is the white veil in front of the pupil at the time of birth. Remove this—modern surgery can do so—and the patient has normal vision. Several such cases have been cured at about 40, and then they see for the first time. But they have to learn what they see. Confronted with a fountain pen the individual may call it anything from a dime to a dreadnought until he slowly learns to use this new sense.

ALL these conditions are very interesting and may result from any type of injury to these local areas. Syphilis is a great offender. Spinal meningitis may leave some such condition, depending on its location in the brain coverings. Even influenza seems capable of affecting the brain, and scarlet fever or diphtheria are of course notorious for the blindness or deafness which may follow. Brain tumors do their share of mischief, while the "stroke" of old age or the "concussion" of youth may result in just about anything. Certain poisons and drugs have a startling but temporary effect—witness delirium tremens or the visions coming from opium. Any interference with the blood supply to one of the local areas results in immediate trouble. This causes the failing senses of old age. The brain arteries become clogged with calcium salts—hardening of the arteries—no blood gets through, and you have those curious lapses of memory for which old people are famous.

But note that, despite all this injury to the very highest levels of the nervous system, we could not describe any of these people as being insane. As a matter of fact, we are just a little puzzled as to why they are not insane. It seems, however, that insanity results only when the brain *as a whole* is involved. For example, any of these particular areas may be attacked by syphilis. The results will be those already described, and the patient is said to be suffering from cerebral syphilis. But note that this disease may also cause the very dangerous insanity known as general paresis. Here, however, the *entire* brain, and no particular area, is injured by the germ. Similarly with brain tumor: a small tumor in one of these areas will give the results already specified, but a very big tumor in some areas will give no results. But if the tumor is so located that it causes pressure on the *entire brain*, then the individual is much safer in an asylum.

Alcohol seems to act in the same way; its effects are generally on the brain as a whole rather than on a particular area. Its first move is to paralyze the very highest centers which, through their controlling action, seem responsible for our ethical behavior. Then it descends in its activity until it produces complete unconsciousness. The various types of insanity connected with alcohol, such as delirium tremens or alcoholic hallucinasis are the result of poisoning to the entire nervous system. This, needless to say, occurs only in cases of great excess. Various other drugs, such as morphine, can give a picture of temporary insanity. We even have such cases from bromine poisoning.

FINALLY, poisons from within the body itself can produce the same results, although these are generally temporary in nature. The delirium which accompanies pneumonia or typhoid fever is the effect of poisons from these germs acting on the brain. One of the best cases of manic insanity I ever saw, a case so violent that I made his acquaintance while he was strapped in a hot bath, was the result of an infected appendix. To be sure, the condition was only temporary and cleared up with the infection, but it was most convincing while it lasted—just as is the individual who is "fighting drunk."

Insanity, when it is a matter of brain injury, is a diseased condition of the entire brain. In some cases we have to do shrewd guessing. Epilepsy, for example, we class as a type of insanity. We have every reason to believe that certain poisons arising from the digestive tract produce the "fits" and the emotional excitement that accompanies the condition. Indeed we can even control the fits by means of the ketogenic diet and dehydration, a method at present so severe as to be impractical. But we still cannot put our finger on the poison, though we are certain it exists. Dementia praecox, most common of all insanities, quite incurable and generally classed as one of those diseases which involve no brain injury, is said to be yielding to treatment by insulin, in Vienna. If so, many a chapter of abnormal psychology must be re-written and this type of insanity must be added to those involving a diseased brain.

We should throw in a word of caution here. Do not confuse the insane with the feeble-minded; it is a very easy error to make. Feeble-mindedness is also dependent on defective brain activity—indeed we may say it is *always* linked with an injured or undeveloped brain, and that this condition can generally be demonstrated to exist where it occurs. We classify the feeble-minded into two broad groups, the "poor stock" cases and the "clear sky" cases. In the former, the condition is essentially due to heredity and the brain is generally very poorly developed. The "clear sky" cases illustrate our thesis even better. These are of five types. First, birth injuries, where the brain has been definitely damaged during labor. Then "hydrocephalus" or water on the brain, which prevents the brain from developing. In these cases the head often becomes very large because of this internal pressure. Microcephalus is the opposite condition, the so-called "pinhead" whose head is not large enough for normal grey matter. The "cretin" idiot has not only an undeveloped brain but undeveloped body as well, because of poorly functioning thyroid gland, while finally the "mongolian" idiot still has us puzzled. He is certainly feeble-minded, has a very inferior brain, but no one has yet discovered the reason.

Note that, in the feeble-minded, the individual never *did* have a good brain, whereas the insane has, or at least did have, a high-grade nervous system. The engine is good but the gears are grinding. The feeble-minded never had a good engine at any stage of the game.

Finally, we should answer a question which has probably been troubling you. If the psychologist insists that mental life is always tied up with activity in the brain, how does he explain the so-called "functional" psychoses, such as dementia praecox, where there is no brain injury? There can be no doubt that those who have dementia praecox are just as "crazy" as the best example of brain syphilis, yet the brain, as we examine it after death, is just as good as yours, or mine. Does not this involve a contradiction?

No, it does not, and I think you can easily grasp the point that is involved. We sometimes refer to these functional psychoses as "habit" psychoses. They are also called diseases of the attention, and they can be explained in terms of learning. For instance, little Johnny finds that the boys on the street are too rough. They like to make fun of him, and when he does try to assert his rights, the results are both painful and humiliating. So Johnny retires to the house, reads his fairy books and *imagines* himself a hero, a king, or what have you. He finds it very pleasant—far more so than attempting to prove his rights in the harsh world of reality. So, in accordance with the famous pleasure principle, he retreats more and more into a world of dreams, becomes less and less interested in the world around him, until finally his dreams become real—to him. He loses all contact with the world and is perfectly satisfied to live with his own thoughts. But you can see that no brain injury is involved. It is a "habit" of thought, his attention is fixed on his own dreams, just as yours is fixed on the stock market and, in your spare time your thought "habits" keep you tied to the financial section of the newspaper.

Similarly in hysteria. The child discovers that the very best guarantee to having its own way is to stage a temper tantrum, so it lies on the floor, kicks and screams. Results are (sometimes) excellent. These childish tantrums become "habits" and develop into the hysterical "fit" of the adult. The pervert gives another excellent example. As a child he learns homosexual activities, continues these into adult life and becomes the pervert.

We call these disturbances functional because the brain is all right as to structure, but it functions wrong; yet such mental disorders are just as dependent on brain action as if caused by syphilis, alcohol, or a brain tumor.

Perhaps the most annoying type of individuals who cross the psychologist's path in a professional way are those hide-bound "structuralists" who insist that insanity *must* be linked with brain injury. They form a whole school and spend their research lives with both eyes glued to a high-power microscope, duty bound to demonstrate the injury which *must* exist in the brain of the dementia praecox. If no such condition can be demonstrated it simply means that the microscope is not good enough. Should you venture to assert that perhaps the brain tissue is in no way diseased, you are at once dubbed a "supernaturalist," and that of course closes the argument —for them. As one such believer in the occult, I repeat my position. That type of human behavior which goes with insanity is always linked with brain activity -faulty brain activity if you will—but this does *not* necessarily imply injured brain tissue.

THE point of this article is that mental life—and by that we mean consciousness—is probably always associated with activity of nerve tissue, but the picture is not always a simple one. Injury to your nerve cells at the lowest level has little effect on consciousness, and results in the higher levels—brain base and brain itself—are various, dependent on where the injury takes place. Certainly all brain injury does not yield insanity, and probably a great deal of mental disease exists without anything of disease in the nervous system. But, for all that, you must bear in mind how great is our mass of evidence that consciousness depends on a brain. Any good surgeon, if he wished, could rob you of the ability to read, to write, or to speak. He could paralyze anything from your toe to your entire right side, or leave you in a condition where your next and permanent address would be the state asylum. The functional insanities do not in any way disprove this contention.

Tracking Down Your Trade Mark Title

You Own Your Trade Mark, but Can You Prove It?

By SYLVESTER J. LIDDY
New York Bar

WHEN an individual, firm, or corporation adopts a trade mark it is usually with the thought that some day the right to that trade mark may be a vital factor in the future of the business in which it is used. Despite this fact, adequate steps to protect that right are but rarely taken.

Ordinarily what happens is this: Someone in the organization thinks of a good word mark or design mark, or a combination of word and design; perhaps a search of the Patent Office records is made to ascertain whether or not the proposed mark has ever been registered—frequently, this is not done. A commercial artist is called in to design an attractive label and perhaps outline an extensive advertising campaign to publicize the new mark. Often, steps are taken to have the mark registered in the United States Patent Office and, where the trade is international, throughout the world.

Too frequently, registration is neglected but even where a registration is effected the trade mark owner usually stops there with a feeling that he has done everything necessary adequately to protect his rights. Such is not the case. For example, years pass and in the interim no one has questioned his right of ownership. Suddenly and out of the proverbial clear sky comes a threat of a claim by someone else of priority of use. Then begins the hunt for evidence. No systematic files of trade-mark data and memoranda having been kept, the hunt and the search become a hit or miss proposition. The owner of the trade mark plaintively states that he was not thinking of law suits when he adopted his trade mark. Had he thought of law suits *then* he might well have avoided one *now* by being in a position to place his evidence before his opponent on short notice and thus end the controversy before it has really started.

How then can such a situation be avoided? It can be avoided by systematically preserving every bit of data which might conceivably throw light on the history of the adoption and use of the trade mark. This sounds like a big order but it is not nearly so complicated or difficult as it seems. It is not sufficient to preserve merely a few old labels. Old labels make fine exhibits but an exhibit is nothing in and of itself when regarded as evidence, unless it can be vouched for by some one who has first-hand personal knowledge that the label, or other exhibit in question, is genuine and that it truly represents the fact or other circumstance claimed for it.

What then should be done? To begin at the beginning: The person or persons who devised the mark should dictate and sign a memorandum for the files that on such and such a day they worked out this particular trade mark, mentioning any circumstance from which they conceived the idea of the particular mark. This should be signed, dated, and witnessed by some other member of the organization so that there can be corroboration in this regard. A notation should be made by the artist or artists who designed the label. Bills for printing, designing, and so on, should be preserved, initialed, and carefully filed in a separate compartment devoted exclusively to that trade mark. Duplicate bills, invoices of first sales (and occasional subsequent sales), as well as specimens of early advertising and advertising copy, should be retained and placed in such file.

WITH reference to the first sales of goods under the new trade mark, proper notation should be made by shipping clerks and others who had anything to do with the early sales and shipments. If the owner of the mark is a corporation, a copy of the corporate resolution of the adoption of the mark should be placed in the trade-mark file together with printer's proofs, sketches and designs, and all preliminary data as well as the finished label. There should be a memorandum in the file pointing to related book entries.

Through the years all changes in the design of the label should be noted carefully. If any radical changes are made in the mark, trade-mark counsel should be consulted. The mark should be registered in the United States Patent Office in its new and varied form. When additional lines of merchandise are added a new registration should be secured covering such additional items and careful notation made in the trade-mark file that item "so and so" was first sold under the trade mark in question under "such and such" a date and the early procedure as to shipping invoices, orders, and book entries, repeated.

It should be borne in mind that oral testimony is frequently uncertain, vague and unreliable. But with actual documented exhibits to refresh recollections and to back up the oral statements of witnesses, particularly where many years have elapsed, the strongest and most convincing proof is furnished.

It must be remembered that at its inception the trade mark in and of itself is valueless and is a mere naked symbol. It becomes a valuable and a tangible right only when it has actually been used and associated in the business of the owner and becomes thereby a symbol of the good-will of the business. Good trade marks have in themselves built up considerable good-will and the mark, which may be of negligible value at its outset, may soon grow in value by leaps and bounds, so that after a period of years the whole business of the owner comes to center around it. That is when the trade-mark pirate becomes interested because it is then that his piracy becomes worth the risk. If the trade mark is backed up by documented facts and documented evidence, the pirate will not get far.

Once the potential value of a good trade mark is really recognized, the time, trouble, and perhaps nominal expense necessary to start and preserve an adequate trade-mark file become well worth while.

POLAR MOLECULES

The New Science of Molecular Structure . . . Old Puzzles Unpuzzled . . . The "Why" of Some Things

By SIDNEY J. FRENCH
Assistant Professor of Chemistry at Colgate University

WHY does alcohol mix freely with water while gasoline merely floats on top? Why does kerosene mix freely with gasoline but not with water? Can kerosene and water be made to mix? Why do salt and sugar disappear in water with the stir of a spoon while powdered sulfur, iodine, or mothballs merely settle to the bottom? Why will soap mixed with water remove dirt and grease?

The answers to these questions and many more like them have puzzled scientists for many years. During the past few years, however, new answers have been found. These answers have come from a study of the sizes, shapes, and charges of the molecules themselves. As a man in the dark may paint a mental picture of an object by feeling its contours, so scientists have pictured the tiny invisible molecules by feeling their "contours" with all sorts of electrical feeling devices. The result is a new science of molecular structure.

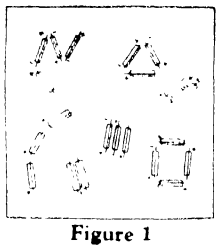


Figure 1

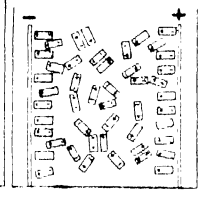


Figure 2

Molecules of water, for example, are now thought to be constructed like tiny magnets having a positive electrical charge at one end and an opposite or negative charge at the other end. For convenience, they may be pictured thus, [+ −], and are known as polar molecules. If a number of needles were magnetized and each placed on a tiny cork float on water, they would tend to form in groups with the positive end of one toward the negative end of another somewhat as illustrated in Figure 1. If the water were stirred, the groups would be constantly broken up and changed about.

This, then, is the scientist's picture of the behavior of water molecules. Molecules pair off, forming groups and figures; they change partners in the perpetual marathon dance; they constantly move about, loath to be alone. Water is aptly termed an "associated liquid" because of the tendency of the molecules to associate with one another. If water is placed between two oppositely charged plates, the molecules line up against the plates as is shown in Figure 2, like dancers lining up for the "Virginia Reel," men on one side, women on the other.

By increasing the temperature of the water, the dance tempo is increased till some molecules are whirled off into space much against their will. Thus, water slowly evaporates as molecules leave the surface. At the boiling point the tempo has become so furious and fast that hosts of partners are torn apart at once to be whirled off into space and travel solitary paths. As the temperature is lowered, the dance tempo decreases till the couples and groups finally take up definite positions and instead of moving about merely vibrate or "shimmy" in position. The water is frozen. Because of the great attraction existing between molecules, they are not easily separated and the boiling point of water is high. For a similar reason, it is easy to "freeze" the molecules in position and water has a high freezing point.

THE molecules of which gasoline is composed are quite unlike those of water. While they are relatively long they have no positive nor negative poles. Hence, they are called non-polar molecules. For convenience they may be pictured thus: (———). There is no attraction between molecules. Each leads a solitary life, though their greater weight forces them to remain close together as a liquid. Each molecule dances alone, frequently rubbing shoulders with his neighbors but bouncing off again to continue the everlasting solo dance. As heat is added and the dance tempo increases, the solitary dancers with no partners to hold them back are easily whirled off into space. Consequently, gasoline vaporizes rapidly and has a low boiling point. Likewise, because of lack of desire to group up, it is not easy to "freeze" the molecules in position. The dance tempo must be greatly slowed down before the molecules quit moving about to take up fixed positions. Hence, the freezing point of gasoline is lower than that of water. Figure 3 illustrates the conditions existing in gasoline—no grouping up.

Gasoline molecules are strictly barred from the water dance hall, first because they are lone "stags" without partners, and second, because they are unattractive. Water molecules greatly prefer their own company. The "caste line" is strictly drawn. Gasoline molecules cannot even wedge their way in between the attractive forces existing between the water molecules. An invisible electrical set of bouncers surrounds the water dance hall. If a gasoline molecule by chance gets in too far, he is promptly bounced back again among his fellows. In their attempt to "crash in," the gasoline molecules spread out on the surface of water looking for an opening till they form a layer only one molecule deep on top of the water. Thus, a tiny drop of gasoline placed on a tub of water may form an iridescent film over the entire surface of the water. Figure 4 illustrates the relation existing between water and gasoline.

On the other hand, alcohol molecules are welcomed into the water society with extended arms, for they too are of the polar caste. They come in groups and pairs to exchange partners freely with water molecules and may thus be whirled off to the most intimate circle of water society. Though they belong to the same caste, alcohol molecules are, nevertheless, less polar than water molecules. Hence, pairs can be more easily separated and the boiling point of alcohol is lower than that of water. For similar reasons, the freezing point is also lower. Thus, the addition of alcohol to water lowers the boiling and freezing points of the water in proportion to the alcohol present. Figure 5 illustrates the dissolving of alcohol in water.

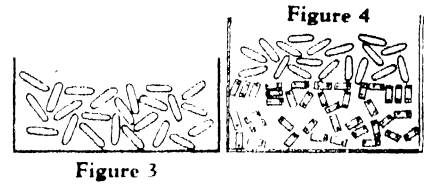


Figure 4

Figure 3

Kerosene molecules, like those of gasoline, are of non-polar caste. They too are solo dancers. As such, they may mingle freely with gasoline molecules, for there is nothing to prevent free mixing. Like gasoline molecules, however, they too are strictly barred from water society. Because the molecules are longer and heavier than those of their gasoline compatriots they are less easily whirled off into space. The boiling and freezing points of kerosene are therefore higher than those of gasoline.

Thus far, only cases of liquids mixing with one another have been considered. However, the situation is quite similar when solids are mixed with liquids. Sugar, because it dissolves in water and not in gasoline, must be made up of polar molecules. The molecules are not simple polar molecules like those of water, however. They are large and heavy and each has several polar "hooks." The molecules might be pictured as in Figure 6.

SUGAR, like frozen water, is a solid. Evidently the attraction between polar groups of neighboring sugar molecules is sufficient to hold them in fixed positions. The music does not start till the temperature is raised and there is no free dancing of either pairs or groups. But sugar is welcomed, nay, urged to enter a water society. But the analogy must be changed. The smaller water molecules, like tug boats, pull and tug at the giant liner to free her from her moorings to neighboring liners. Having freed one liner, other waiting tug boats attach themselves to the next, and so on till each liner, escorted by numerous tug boats, is traveling about through the tug boat infested sea. Thus, sugar molecules in a lump of sugar are torn apart by the energetic water molecules to become members of the joint water-sugar society. Figure 6 illustrates the dissolving of sugar in water.

Salt is a peculiar substance in many ways. Instead of having polar molecules like sugar or water, the molecules have

Figure 5

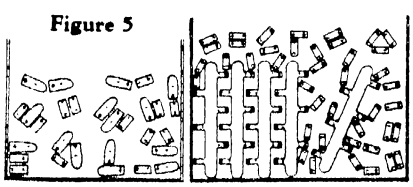


Figure 6

been broken apart so that the positive charge is isolated in one of the parts and the negative charge in the other. The situation can be represented thus: [+]—[−]. The parts are known as ions (meaning wanderer) since each part may travel its own path somewhat independently of the other. In a salt crystal, the positive ions cling to the negative ions, much as oppositely charged pith balls cling together quite strongly.

When a lump of salt is placed in water, the water molecules are strongly attracted to the outside ions and begin tugging away at them. In the tug of war between the pulling of the water molecules and the tendency of the ions to cling together, water wins. One by one the lump is stripped of its outer ions till nothing remains. Each ion is then escorted through the solution by its water molecule escort. Occasionally, escorted ions of opposite charge come so close together that they temporarily escape from their water guardians to re-unite, but the ever-moving watchful water molecules see to it that divorce is prompt. Figure 7 illustrates the dissolving of salt in water.

Solids such as iodine and moth balls belong to the non-polar caste. Hence, the molecules have no polar hooks to which water molecules can attach. In fact, they cannot "crash" the water dance floor because of the ever-vigilant electrical bouncers. However, they are welcomed in the non-polar society of gasoline or kerosene as solo dancers. The moving gasoline molecules by mere collision with the solid substance tear off the outer molecules and permit them

Figure 7

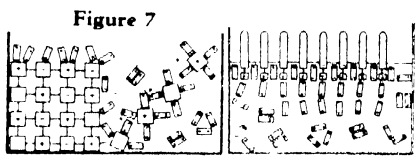


Figure 8

to solo dance. These heavy molecules are "kept moving" only by constant collisions with the lighter gasoline molecules.

The simple rules of solubility may be summed up in two statements.

1. Polar liquids, such as water, dissolve other polar liquids and solids as well as ions, but will not dissolve non-polar substances.

2. Non-polar liquids, such as gasoline, dissolve other non-polar liquids and solids, but will not dissolve polar substances.

Soap also has an unusual type of molecule—while one end is of the non-polar type, the other is polar. It can be represented thus: [—] [+]. This odd situation makes the soap molecule literally an amphibian. In water it swims with the non-polar end waving in the air, in oil with the polar end waving in air, as is illustrated in Figures 8 and 9. If the polar end of a soap molecule appears at the water dance hall, it is welcomed warmly, but the non-polar end finds entrance difficult though it may enter through the influence of its polar end. It usually finds itself in the anomalous position of being half in and half out. This unhappy molecule finds itself a "half caste" sometimes welcomed in both oil and water, sometimes rebuffed by both. However, the very half caste position makes the soap molecule one of the most useful of all molecules in the social melting pot of molecules.

If kerosene and water are shaken together they quickly separate into two layers on standing. If a little soap is first added, however, small droplets of kerosene remain scattered through the water. There is no separation into layers. The half caste soap molecules have

Figure 9

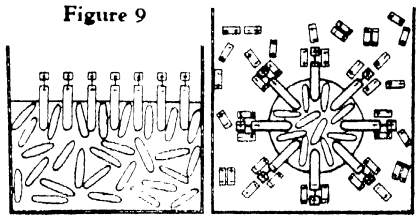


Figure 10

served to make kerosene and water compatible. Even so, the kerosene molecules can be escorted into water society only in groups, never singly. To change the analogy once more, a small unarmed group of kerosene molecules penetrates hostile water territory only when surrounded by an armed soap cordon of police molecules to open the way and prevent attack by the armed and angry water caste. The soap molecules, friends of both groups, are merely the police enforcing the natural law. Figure 10 illustrates the suspending of a drop of kerosene in water.

SINCE dirt, grease, oil, and fat consist chiefly of non-polar molecules it is evident that they cannot be removed from materials by merely adding water. Without its police force, molecular society is undemocratic and dirt cannot enter exclusive water society. Again the police force is called on. Materials are rubbed with soap. The rubbing serves to break the dirt up into groups small enough to be properly escorted. The police molecules form their protective cordons and the escorted groups move off unafraid into the very heart of a hostile society. Thus, because of its dual nature, soap is enabled to bring polar and non-polar substances together and serve as an excellent cleansing agent.

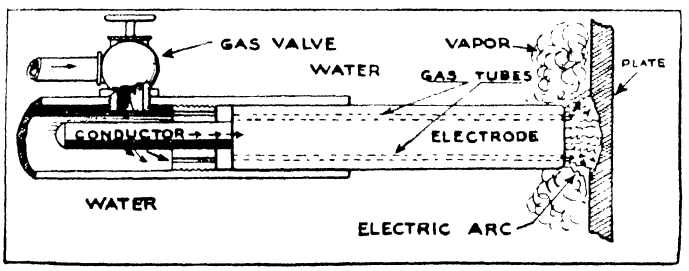
Molecular society, governed by immutable natural laws, is certainly not democratic. The position a molecule must occupy in molecular society was fixed long before that molecule was born in the cooling stars. Nor is there any rebellion against fate. Polar or non-polar, charged or uncharged, associated or single, complex or simple, molecules behave as law decrees they must. Each species of molecule remains in its own caste which is pre-determined by its "electrical contours." Only when properly escorted and protected for the journey may it attempt to cross caste lines.

Arcs Cut Under Water

Electric Torch Rips Submerged Metals . . . Gases Create Working "Hollow" . . . Oxygen Burns Metal Being Cut . . . Possible Welder . . . Many Uses

By R. G. SKERRETT

CUTTING metal bodies under water by burning them with an electric arc is being done far more extensively than most of us are aware. This means of dealing with difficult situations is saving time and money and achieving results that would be exceedingly hard to effect in any other way. As with everything else that the engineer develops, the American electric subaqueous cutting torch has been considerably improved since it was conceived a decade or so ago.



Principal features of the electric underwater cutting torch. The "plate" being cut is grounded and is the return circuit

This extremely adaptable tool makes use of the intense heat of the electric arc and is a great advance over the oxy-acetylene underwater torch that made its appearance first in Europe. That

Diver, with cutting torch, before donning helmet to work submerged

torch had to be ignited in the air and then carried very carefully down into the water to prevent being extinguished. It had also to be held within a limiting angle while working submerged; if doused by the flooding of the cup around the flame the diver had to make his way back to the surface to have the gas re-ignited.

The electric torch, on the other hand, has none of these hampering restrictions. With the current switched on, the diver has only to touch with the tip of the tool the metal to be burned and then to retract the electrode a fraction of an inch. Since the metal body acts as the "ground," or return circuit, an incandescent arc is produced, and that arc, with jets of high-pressure oxygen issuing from the tip of the electrode, melts the opposing metal and blows the fused particles away. The great heat of the arc and the gases of combustion vaporize the enveloping water and create a cavity in which the arc can do its work. The arc ceases the moment the tip of the tool is withdrawn less than an inch from the immersed metal. The electric torch works equally well in any position, at any depth, and is unaffected by the temperature of the water.

IN its earlier form, the electrode was a round rod of carbon with longitudinal passages for the emission of the compressed gas at the tip. Today, the carbon is rectangular in cross-section. This gives the diver a choice of a corner or of a wide or short edge to meet the conditions best suited to the desired cutting. Even resistant cast iron and manganese bronze can be cut under water with one of these torches, and up to date the tool has successfully burned its way through any metal encountered.

With a current at sufficient pressure to produce the required arc, it should be plain that a diver must be heedful that the tip of the tool does not touch any metal part of his suit when the current is switched on. Therefore, the risk is reduced by using direct current which, unlike alternating current, exerts a repulsive force when near a metallic mass; but even the latter current might shock a diver if the bared tip touched him. The torch is truly a two-edged instrument that can be entrusted only to a qualified expert, and even then the unexpected might happen. It has been known to burn a long furrow in the metal breastplate of one diver on striking accidentally a glancing blow.

When functioning properly, the arc has the sound of a vigorously boiling kettle with intermittent cracklings—the latter being due to the rapid expansion and contraction of small globules of molten metal blown away from the cut. An expert, even if he cannot see the tip of his torch because of muddy water, is guided by sound in holding the tip continuously about a quarter of an inch away from the metal he is fusing. It takes much practice to reach this stage of expertness.

While developed originally to aid in submarine salvage operations, the electric underwater metal-cutting torch is now used in many other fields of engineering service and probably in the largest number of instances in the repair, inspection, or cleaning of subaqueous water mains and similar conduits. Lately, the torch has been much employed in removing sections of heavy steel sheet piling that had to be cut off level with the bottom of some waterway to prevent interference with shipping, and in a number of cases in recent

An unusual photograph of a diver cutting metal in water with an electric cutting torch

years the torch has been of the greatest service in removing the tangled steel structures of collapsed bridges or in getting rid of the submerged parts of old bridges that have been supplanted by new structures. Indeed, on one recent occasion, the damaged span of a bridge, with one end underwater and the other end still connected to an associate span, was released so that the whole span could drop to the bottom of the river. In that position the torch cut the steel fabric into sections that could be easily lifted, one by one, by a floating derrick and landed on a convenient wharf. That procedure was the simplest and least costly one to follow.

DURING last summer, the water in the Great Lakes reached an exceptionally low level. Many of the large cities bordering the Great Lakes obtain the major part of their essential supply of water from those bodies; and, to avoid contamination by sewage, the intakes are located far out from the shore. These intakes are usually circular shafts or tubes, rising vertically, equipped with gates in their sides. At one intake crib, the gate openings were nearly half their height above water, because of the lowness of the lake, and the inflow of water was seriously diminished. The only solution lay in cutting away to a greater depth the gate openings in the cylindrical iron intake well. In the course of an afternoon and evening a diver equipped with an electric underwater cutting torch did his work so well that the openings were extended far enough to permit the admission of an ample supply of water.

At a new bridge across a river in Pennsylvania, the piers were built in the dry within enveloping cofferdams formed of steel sheet piling driven firmly into the bed of the stream. The contract required that all the piles should be pulled out after the piers were completed; but a heavy rainfall abruptly transformed the river into a raging torrent before all of the piles could be removed, and eight of them remained and were bent away from the neighboring pier by the sweep of the turbulent flood. When the river became calm again, the deformed piles could not be pulled, and the only way to get rid of them was to cut them off level with the water bed with an electric torch.

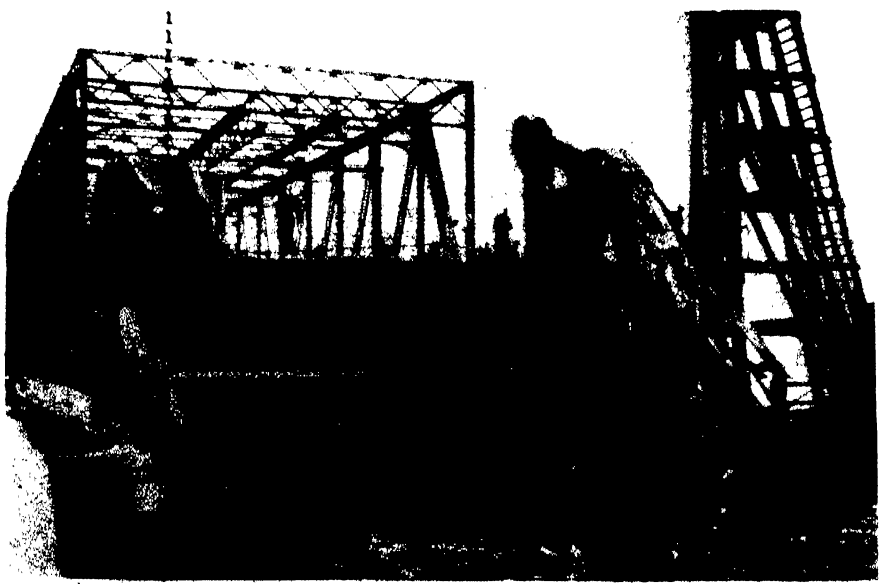
On the upper Mississippi River, where the Government is building a series of locks and dams to promote waterborne trade at all open seasons, much of the construction work has been and is being done within unwatered cofferdams built of steel interlocking sheet piling. At Lock No. 9, the piling at the corner of a cofferdam, situated where the river ran strongest at high stages, was so bent and twisted that the steel sections could not be pulled in the usual way by the ordinary equipment. They had to be removed, notwithstanding, to clear the river channel. Again, a diver and an underwater cutting torch were brought into play.

A seaboard dredge had the steel casing on one of her spuds, or anchoring spars, very badly bent and curled up at one corner where it had struck a rocky bottom; when that spud was raised, the deformed metal jammed in the well or passage in the vessel through which it had to move up and down. The craft was crippled, and to make her fit for service the jammed spud had to be released. Instead of taking the vessel into a drydock the hampering bent steel was cut free with an electric subaqueous torch.

In marine work, in addition to cutting openings in the steel structures of sunken craft to facilitate their salvage, torches such as have been described are employed to remove wire cables that have been caught in propellers and wound about them so that they could not be turned; every now and then a propeller, put out of balance by the damaging of a blade, is made smooth-running again by removing a corresponding area of an opposite blade. This work does not entail the expense and loss of time of drydocking, and it gets rid of the annoying, and often serious, vibrations in a ship which an unbalanced screw will cause. There is no telling where the underwater metal-cutting torch may be put to service next. This tool, which seems to violate all of our long established ideas about the normal antagonism of fire and water, is one more evidence of what the inventive mind and the engineer can bring about in harmonizing naturally opposing forces and thus achieving the supposedly impossible.

Twenty tons of crumpled steel plating cut from a sunken ship's hull

RESEARCH work has blazed the way for another valuable application of the under-water metal cutting electric torch. Laboratory experiments made a year or two ago indicated that such a torch could be used to weld metals under water—the arc then serving to fuse metal rods so that the molten metal could be deposited subaqueously to bind together contiguous metallic bodies. The resultant welds when tested revealed excellent physical qualities. The first practical employment of this process was recently made by an oil company on the Pacific Coast. Some of that concern's submerged pipe lines were found to be impaired by corrosion pits that would eventually lead to leaks. It is reported that the pitting in the pipe walls was remedied, after the areas were cleaned, by filling the depressions with metal melted with the electric-arc torch, primarily designed for cutting work—another example of the way the engineering world moves onward.



When the steelwork of this bridge collapsed, the cutting torch cut it under water into small pieces to facilitate removal, speedily clearing the river bed

STRANGE SENSATIONS

Tests for Color Blindness . . . Most Prevalent in Males . . . Color Blind Interior Decorators . . . Taste is also Deficient in Some Individuals

By LAURENCE H. SNYDER
Professor of Zoology, Ohio State University

A RESERVE officer at his first summer encampment was undergoing the usual physical examination upon arrival. In the course of the examination a test for color blindness was given. The officer was found to be quite color blind. Turning to an acquaintance in the line, he said: "That is very strange. I am chief chemist at a large pottery works, and one of my most important jobs is to pass on the final blending of the colors in the pottery!"

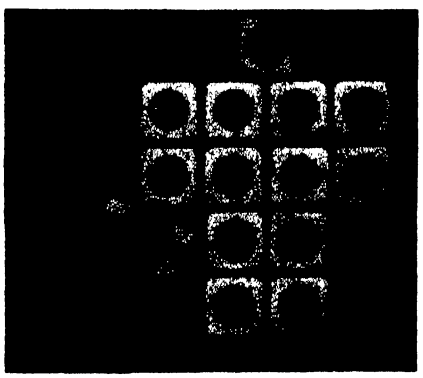


Figure 1: **A test for color blindness. Numerals built up of dots camouflaged (to the color blind) by dots**

A prominent zoölogist who has spent the greater part of his life studying fishes, and has described many new species, including, of course, color descriptions, discovered after he was past 60 that he was color blind for all the pastel shades.

A physician, in discussing color blindness, said that he was 21 years of age before he knew that there was any way to tell that cherries were ripe without pinching them.

An ornithologist, who taught college classes in bird study for several years, prided himself on the fact that he taught his students the songs of birds. He himself was able to tell practically any bird by its slightest sound. It was not until some years later that he discovered that the reason why he learned bird songs was that he was so color blind that he had never really seen a bird in nature. Bird skins and stuffed specimens in the laboratory were his source of knowledge concerning shape and structure, but in the field song was his necessary guide.

The strange thing about color blindness is that the person with this trait as a rule never realizes it until he has been given some standard test. Even then he frequently refuses to believe it. What he has always seen seems perfectly natural to him, and not until he thinks back to many little incidents of his past life will he be able completely to accept the fact that he is deficient in the sense of color.

COLOR blindness is of various sorts. Rarest of all are the people who are completely color blind. To them the world is composed entirely of various tones of gray, much as a photograph would appear. Less than 100 cases of total color blindness have been recorded in all the world, and other physical defects of the eye usually accompany the condition. This type of color blindness occurs equally in both sexes, and is inherited as a recessive character; that is, it may skip generations and then crop out again.

The next most rare type is "pastel shade" color blindness, a condition in which the affected person can see bright colors with ease, but cannot distinguish the various lighter shades. This type of defect is largely confined to males, and is hereditary, although as yet nothing very definite is known as to its exact mode of inheritance.

Red-green color blindness is the commonest of all forms. It exists in varying degrees, but always involves difficulty with the distinctions of reds and greens. It has been recognized for a long time, family pedigrees from the 18th Century being known. This type of color blindness again occurs far more commonly in men than in women. Its mode of inheritance is well understood, being what the geneticists call "sex linked." Red-green color blindness may appear in a boy when neither parent shows the defect, but it does not ordinarily appear in a girl unless her father was color blind. A color blind father will not transmit his defect to his sons, but will transmit it through his daughters to half of their sons. If a color blind man marries a woman who has color blind relatives, some of their daughters are very likely to be color blind. A color blind mother, on the other hand, will have sons all of whom are color blind, and will likewise transmit it through her daughters to half of their sons.

If both parents should be color blind, all the children will show the defect. Color blindness is occasionally the result of disease or injury, such as injury to the optic nerve by tobacco or alcohol. Such cases, being *acquired* color blindness, would, of course, not show hereditary transmission.

Numerous tests for color blindness have been devised. These include the matching of yarns, the recognition of symbols or figures in color mosaics (Figure 1), and the projection of colors on a screen for recognition and comparison. A most interesting test is the Japanese chart devised by Ishihara, in which certain numbers are visible to the normal observer, while quite different numbers appear to the red-green color blind person, and the pastel shade color blind individual sees no number at all.

About one boy in 12 or 15 is color blind, and about one girl in a hundred. A surprisingly large number of interior decorators suffer from the defect.

The camera is color blind. On the color mosaic test, the camera records the number visible to the red-green

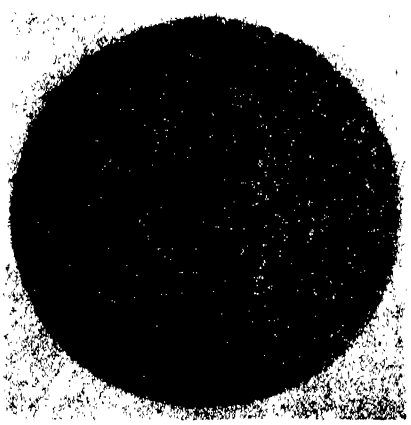


Figure 2: **What the camera, also a red-green color blind person, sees but not what a normal eye sees**

color blind person, and not the number apparent to the normal observer (Figures 2 and 3). This fact should provide a good basis for a detective mystery.

Color is not the only sense which may be deficient in various people. Taste is also deficient in many persons. This fact has been known only for the last few years. It was discovered quite by accident in the laboratory of a large chemical products company. In the manufacture of rubber materials, certain substances are used as "accelerators" of the rubber. While a chemist was preparing one of these substances (para-ethoxy-phenyl-thio-carbamide) the dust from the process flew about the room. An assistant in the room complained of the bitterness of the dust as it got in his mouth. The man preparing the substance was quite unable to detect any bitterness, although he was working right over it. Upon placing small crystals of the substance in their mouths, it was found to be extremely bitter to the assistant, quite tasteless to the chemist preparing it.

THE accidental discovery of this taste deficiency provided an item of much interest to biologists, particularly to students of heredity. Careful studies were immediately inaugurated, and many interesting facts were unfolded as the studies progressed. For this first substance studied, about 70 percent of the population were found to be tasters, while 30 percent were non-tasters. Moreover, this taste deficiency was found to be inherited. The ability to taste the crystals never appears in a child unless it was present in at least one of the parents. When both parents are non-tasters, all the children are non-tasters. In other words, the taste deficiency is inherited as a recessive character.

Following this discovery, a large series of compounds has been tested for taste in a large number of persons, and many of the substances have been found to produce different reactions in different people.

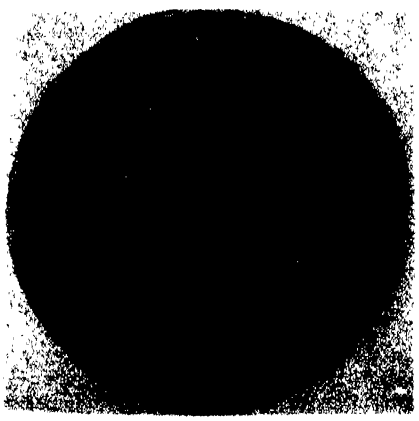


Figure 3: **What the normal person sees. To make the camera "see" it a color filter had to be employed**

People vary in their reactions to the different compounds. An individual may taste certain of the substances and not others. The person who is certain that his sense of taste is exceptionally well developed may be the very one to find one of these substances quite tasteless, while the person who admits that his taste is not acute may find it exceedingly bitter.

Chemical handbooks commonly give the taste of the various compounds mentioned. It now appears that these descriptions must be entirely rewritten, since the recorded taste is merely the reaction of the person who wrote the description, and this may not apply at all to the person who reads it.

Some of the substances tested occur in common foods. Thus creatine, a common constituent of lean meats, is tasteless to a goodly proportion of the population, while having a characteristic taste to the remainder. A pound of lean meat may contain as much as two grams of creatine: an appreciable amount when it is realized that a single crystal of one of these substances is enough to provoke a strong taste reaction. Soups made from lean meat contain a good deal of extracted creatine, which must mean that soups have decidedly different tastes to different people.

Figure 4: **Keeping taste compounds at fixed temperature for the tests**

Other substances occurring in foods are at present being investigated for their differential taste-producing qualities. It may very well be that, when you say to your child at the dinner table, "Now you eat up all that spinach or I'll spank you and put you to bed," the spinach tastes very different to the child than it does to you.

The hostess of a large and famous restaurant recently heard of the newly-discovered taste deficiency, and immediately sensed a possible practical application. She has found that it is sometimes necessary to discharge chefs, because, while skilled in cooking and preparing meals, they are quite unable to produce the flavor and seasoning which patrons desire. Tests for taste deficiency to various substances of this nature are now being developed.

Figure 5: **Taking a standard taste test in a scientific testing laboratory**

A short time ago rubber ice trays for electric refrigerators made their appearance. In producing such rubber articles, compounds of the nature of para-ethoxy-phenyl-thio-carbamide are used. The first rubber ice trays were soon found to be objectionable to certain persons because they gave the ice and the ice water a bitter taste. A compound which would not excite a bitter taste in anyone had to be found for use in accelerating rubber. At present great care is taken to use compounds which are tasteless not only to the inventor in the manufacturing plant, but to everyone else. This is also true in the manufacture of rubber nipples for babies' use.

Not only do people vary in their reactions to crystals or strong solutions of many compounds, but they vary in the strength of their responses. A very weak solution of one of the carbamides is tasted by only a small percentage of the population. Stronger and stronger solutions are tasted by an increasing proportion of the population, until nearly everyone tastes a saturated solution. Temperature also plays a part in the strength of the reaction. Experiments to unravel the complexities of taste and its inheritance are being carried out in several scientific laboratories at present (Figures 4 and 5).

VARIATIONS in sensations could be multiplied, but enough has been said to indicate that our reactions are not at all alike even to the most commonplace things. Tone deafness, odor deficiency, and others are being investigated. We are born with different capabilities. No matter what trait we care to measure, we find that people differ. Much of this variation has a definite hereditary basis. Truly we live in different worlds.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
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D. H. KILLEFFER
Chemical Engineer

Pawnbroker's Microscope

HOW much will you lend me on this fine blue diamond? This is the question one Bausch & Lomb technician is asking the other in the accompanying illustration. Because borrowers are asking this question of pawnbrokers every day, the Provident Loan Society of New York, world's largest pawnbroker, will give its

Wide-field binocular microscope fitted for examination of gems

answer through a new microscope to the people who borrow more than 25,000,000 dollars annually from the company on pledged jewels.

Handling this enormous amount of personal jewelry requires the closest scrutiny by gem experts. Good quality synthetic corundum, such as sapphire or ruby, may be so free from flaws as to conceal its nature completely from the hand lens. White zircon, white sapphire, and even white quartz are sometimes substituted for diamonds, or green spinel and green sapphire for emeralds. A thin layer of genuine material is often backed by material of practically no value.

The new wide-field binocular microscope is fitted with a ball and socket chuck upon which rings, studs, and small jewelry may be mounted and turned in any position to secure the advantage of transmitted light through the stone. Replacing the familiar watchmaker's loupe, the pawnbroker's microscope holds the jewel rigid while the gem expert examines the stone to determine its axis; searches for impurities in inclusions; notes the perfection of its facets; and determines whether it is a substitute, an imitation, a synthetic stone, or the real thing.

Biologist Produces A Live Unicorn

UNICORNS no longer belong wholly in the doubtful twilight of mythology, where dwell griffins, dragons, and such-like fabulous beasts. There is a live unicorn right here in the U. S. A. of this modern

***Above and right:* Two views of the live unicorn created by a biologist**

year 1936. Nor is he under the suspicion and ban of science; quite the contrary, science is responsible for his existence.

The 1936 model unicorn was produced by Dr. W. Franklin Dove, biologist at the University of Maine, through a rather simple surgical operation on the head of a day-old bull calf. By transplanting both horn buds, or little knots of tissue that normally produce a pair of horns, to a close side-by-side position at the center of the calf's brow-ridge, Dr. Dove induced the growth of a single very massive horn that has proved to be a most efficient weapon. Indeed, so much more successful has it been than the usual two horns that its proud possessor has undisputed domination over his companion cattle, and has developed much of the proud yet unaggressive bearing and disposition ascribed to the unicorn of fable.

The operation by which Dr. Dove's bull calf was enabled to become a unicorn was similar to some of the tissue transplantations used in plastic surgery on human beings, to remedy the disfiguring loss of a nose or other facial feature. When the horn buds were cut loose from the young animal's skull, a strip of skin and underlying flesh was left attached to each one, to carry the normal blood supply until the transplanted beginnings of horns could take hold on the spot where they were planted. Also, since the horn buds are circular, Dr. Dove cut their adjacent edges flat, so that he could set them close together, and so encourage the growth of a single horn mass.

The Maine unicorn is now about two and one-half years old, a splendid young animal of the Ayrshire breed. He is strong, fearless, well able to fight though seldom doing so. His biological "inventor" holds that his marked docility is due largely to the fact that the unicorn knows his own strength and the superiority in combat that his single weapon gives him; full self-confidence has done away with truculence.

Dr. Dove has searched the literature of

FRUIT—LEAVES

THIRTY to 40 leaves are necessary to produce the food to develop each peach on a tree. Forty to 50 leaves are required to develop a good-sized apple, and about 50 for an orange.

unicorn lore, which is both ancient and voluminous. He is strongly inclined to believe that earlier peoples anticipated him in his unicorn-making surgery, and that they produced leader animals for their herds in this way. One passage in Pliny, noted naturalist of Roman times, indicates that ancient herdsmen operated on the horn buds to produce multiple-horned beasts. Other more modern references indicate that shepherds in the Himalayan state of Nepal made unicorns of rams, and that two African peoples knew the secret of unicorn cattle.

Everywhere in ancient literature, both Biblical and classic, the unicorn is credited with great strength, great nobility, and great independence. He is always the leader of the beasts. His single horn, tipped with red or black, is the symbol and source of his power. He rules the others with it; he dips it into pools of undrinkable water and takes away the poison. Yet he is gentle, so that he will obey even a young girl. Later legend stresses this point, until it was claimed that only a virgin could tame a unicorn.

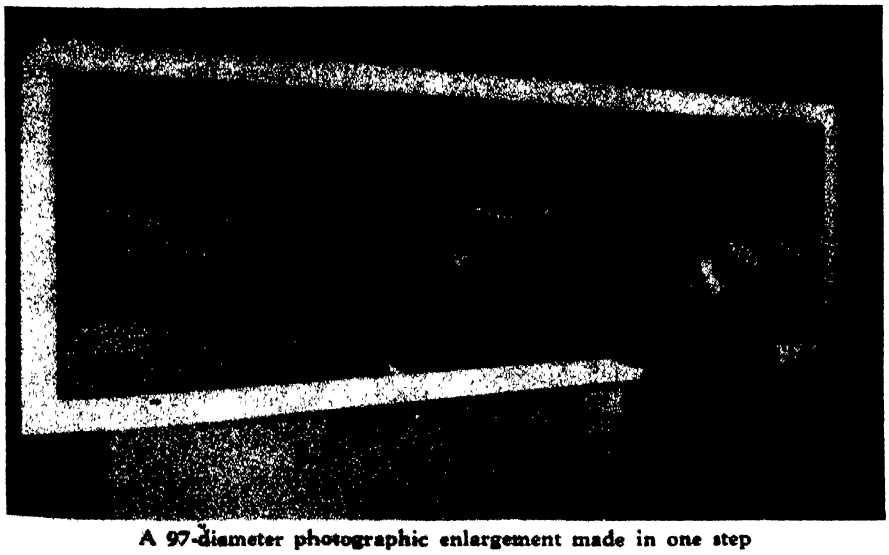
The unicorn is mentioned three times in the Old Testament, always in terms of high esteem. Indeed, the first reference, in the Book of Numbers, likens the unicorn even to God. Balaam, the heathen prophet who ran full tilt into the power of Jehovah, and of course got the worst of it, reported back to his king: "He hath as it were the strength of an unicorn!"—Copyright *Science Service.*

Remarkable Photographic Enlargement

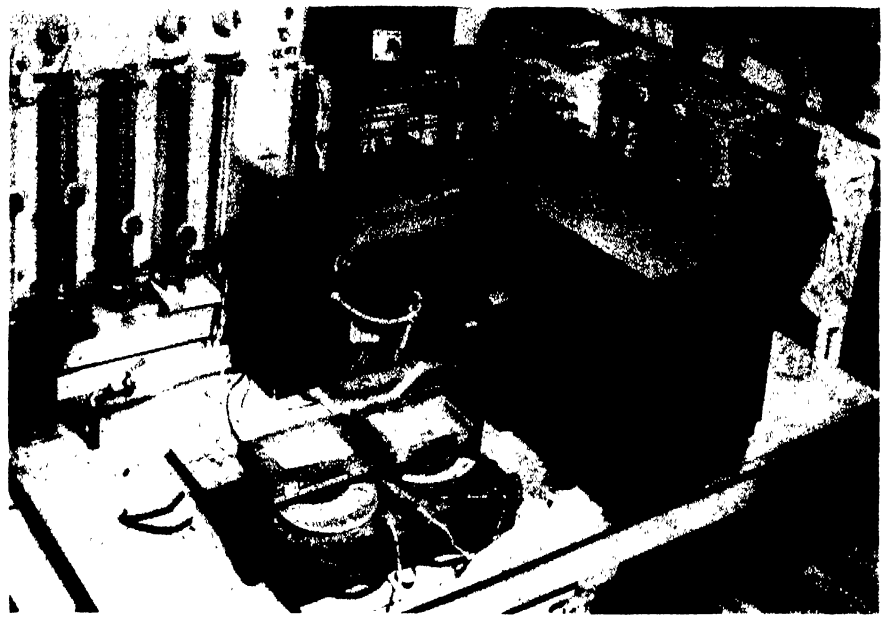
A NEW record in photographic enlargement has been achieved by the well-known New York photographer, Ivan Dmitri, using duPont Superior Panchromatic Film. This photograph, showing Wyoming wild horses in action, was made from a one-inch by one and three-eighths-inch negative which was enlarged in a single step, without retouching, to a size measuring eleven feet two inches by forty inches the greatest single-step enlargement known. The feat is all the more remarkable because only a three-eighths-inch by one and three-eighths-inch section of the original film was used. This is a 97-diameter enlargement, increasing the area of the picture 9400 times. Its accomplishment suggests greater possibilities in enlargement through the use of improved film, as an eight-inch by ten-inch negative, enlarged proportionately, would produce a picture half a block long and six stories high.

According to Mr. Dmitri, no special technique of operation is required for such an enlargement, the results being made possible mainly through improvements in fine-grain film, fine-grain technique, and color synthesization. Mottled effects of "grains"—due to films and developers—formerly prohibited a single-step enlargement of this extent. With the improved film, this is no longer a serious factor.

Mr. Dmitri emphasizes the fact that research on lenses, films, and developers, conducted by expert technicians, at a cost of millions of dollars, has given the photographer more adaptable materials and allowed him to spend more time on artistic composition. Until lately, it was necessary for the amateur to devote many hours to acquiring deep technical knowledge. Now, better equipment has relieved him from this requirement and widened the scope of the camera in art.



A 97-diameter photographic enlargement made in one step



The monochromator, which emits light of a single wavelength

And What's a Monochromator?

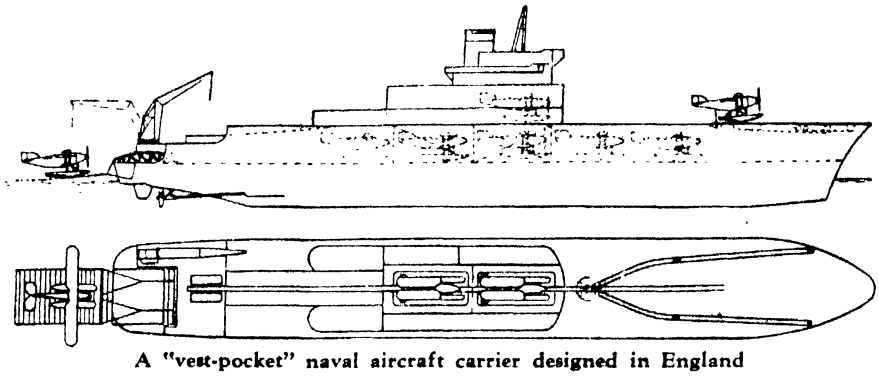
IN operation today in the Research Laboratory of the General Electric Company is one of the world's most powerful sources of single-colored light and monochromatic ultra-violet radiation—known technically as a monochromator. The function of the equipment is to take the light given off by a mercury vapor arc and, through the use of an optical system, filter out all except a few of the vibration frequencies present in the light. Through this operation the instrument produces single-colored, single-frequency, or monochromatic light.

The optical system of the instrument, its most important feature, was made possible by the development in the General Electric Company some years ago of clear fused quartz. Through this development it was possible to produce the large seven- and ten-pound quartz prisms which constitute the heart of this powerful monochromatic apparatus.

The apparatus consists essentially of an ultra-violet source, entrance slit, entrance collimating lens, the two large fused quartz prisms, exit collimating lens, and the exit slit. Purity of the radiation is obtained by changing the corner angles of the two prisms in such a way that the greater portion of the unwanted wavelengths of light are refracted out of the optical system to be absorbed by black shields.

Prevents Mildew On Paint

WHITE paint on interior surfaces subject to moisture frequently turns black as a result of mildew. Paint chemists have found that small amounts of mercury worked into the paint as a paste will eliminate this nuisance. A mildew preventive consisting of 73.8 percent by weight of zinc oxide, 1.2 percent by weight of bichloride of mer-



A "vest-pocket" naval aircraft carrier designed in England

cury, and 25 percent by weight of linseed oil, forms a smooth, easily workable paste for use by painters. *Paint, Oil & Chemical Review* points out that such pastes must be marked with appropriate warning labels, as mercuric chloride is a deadly poison.—*A. E. B.*

High-Speed Naval Aircraft Carrier

THERE is no doubt but that the aircraft carrier is an indispensable element of any navy, if that navy's airplanes are to be effectively used. The disadvantages of aircraft carriers lie in their immense expense, large size, and the fact that they are vulnerable to attack. It would seem, therefore, that a small aircraft carrier of high speed, extreme mobility, and cheapness of construction and operation would be of interest.

By courtesy of *Flight*, a sketch of a "vest pocket" aircraft carrier designed by John I. Thornycroft and Company in England is shown herewith, in which these objectives are sought. An interesting feature of the carrier lies in the employment of the Hein landing apron or "canvas" similar to that employed in the German-South Atlantic service.

At the bow of the vessel a catapult is provided which will handle aircraft up to 8000 pounds in weight and catapult them at 57 miles an hour. The catapults are designed to be exceptionally long so as to permit gentle acceleration, thus making their operation safe for aircraft loaded with bombs. There is an advantage in placing a catapult at the bow since the speed of the ship helps in increasing the relative wind. If, for example, the minimum speed of an airplane is 57 miles an hour and the carrier is traveling at 27 miles an hour, only 30 miles speed is necessary at the catapult.

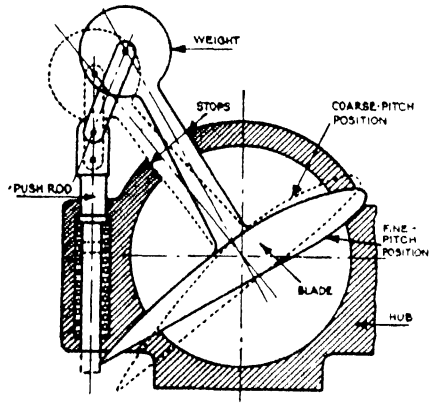
The Hein canvas allows an airplane to be picked up while the carrier is itself maintaining full speed, so that it is less vulnerable to torpedo attack by submarine.

With the conventional aircraft carrier, the deck has to be long enough for the airplane to alight. With the new design the over-all length of the carrier is 360 feet and the displacement only 3000 tons. With a shaft horsepower of 40,000, a speed of 28 knots is expected of the new design.—*A. K.*

Automatic Variable Pitch Propeller

CONTROLLABLE pitch propellers are usually considered as somewhat complicated pieces of mechanism. The Schwarz automatic variable pitch airscrew, however, which has been successfully tried out in Germany, is exceedingly simple in principle and execution, as can be seen from the drawing.

The propeller blade is so mounted in the hub that it is free to rotate in its end bearings, with the rotation limited by two stops. At the same time the propeller blade on each side is controlled by two opposing moments: one due to the push of the spring shown at the left of the diagram; the other



The actuating mechanism of a new automatic variable pitch propeller

due to centrifugal force acting on the weight shown at the top of the diagram.

At take-off and climb, when the engine is turning up relatively slowly, the moment of the spring is greater than the moment due to the centrifugal force of the rotating weight. Accordingly the blade is pushed over to the right stop, and assumes a "fine" or low-pitch position. It is this position that is desirable for take-off and climb.

When the airplane changes over from the climb to high or cruising speed and the engine speeds up, it is the rotating weight which takes charge, and the blade accordingly moves over to the other stop. The airscrew assumes the "coarse" or high-pitch position, and at high speed it is the high-pitch position which is desirable on the score of aerodynamic efficiency.

Therefore the blade acts efficiently under all the main conditions of flight.

Of course, with a manually controlled variable pitch propeller, or with the constant-speed variable-pitch propeller of American practice, a better coordination between plane speed and propeller pitch can be attained, since more propeller settings are available. But the simplicity and light weight of the new device give it claims to serious consideration. *A. K.*

RIO AIRPORT

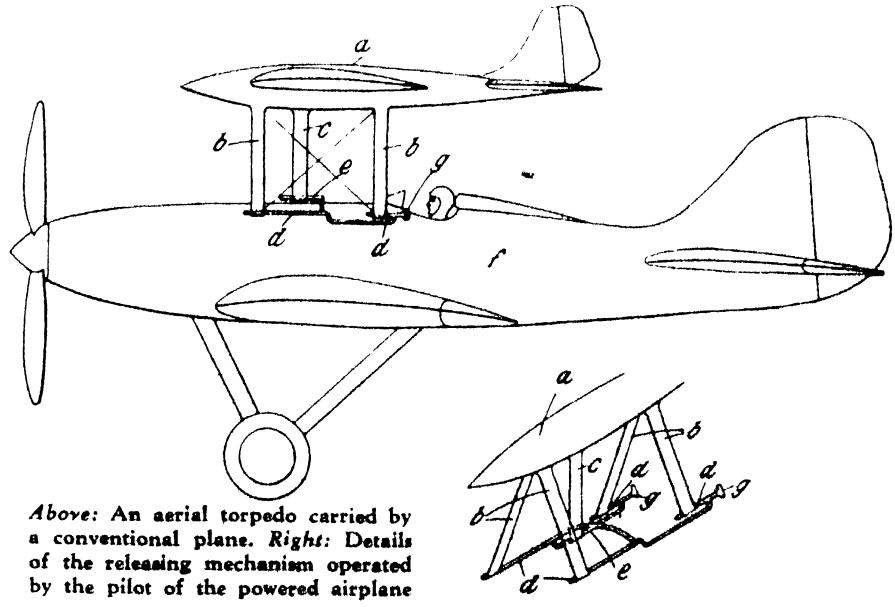
CONTRACTS have just been let for Brazil's new Federal Airport at Rio de Janeiro. Designed to accommodate the giant Pan American, Clipper type, flying boats, the airport will be only two minutes' ride from the heart of the South American city.

An Aerial Torpedo

THE *London Aeroplane* of recent date contains the following significant sentence: "No nation will officially admit the existence of wireless-controlled pilotless aeroplanes which carry high explosive instead of crew and are thus in effect dirigible flying bombs."

Captain Norman Macmillan, a noted British aviator, has disclosed his ideas for a dirigible aerial torpedo, although not wireless-controlled, which is illustrated in the diagram.

Above a conventional airplane *f* is mounted a smaller "pilotless" airplane *a*. The pilotless airplane carries the bomb. The smaller machine is supported on the struts *b* and *c*. When the pilot pulls the handle *g*, the locking pins *d* and *e* are withdrawn and the bomb-carrying craft is launched into space following the same path as did the piloted airplane at the instant of release.



Above: **An aerial torpedo carried by a conventional plane.** *Right:* **Details of the releasing mechanism operated by the pilot of the powered airplane**

The pilot can then dive or turn back while the dirigible bomb glides down to its target.

There are certain to be practical difficulties in the realization of this conception, but it certainly has interesting features. Bombing could be carried out with far less hazard to the pilot, and the protective aprons of captive balloons could be readily pierced without hazard to the attacker.

Other possible refinements are gyroscopic control of the flight path, and control by an aneroid to flatten the trajectory when attacking targets of low elevation, such as warships.—*A. K.*

Faster Training Planes

PART of the 61 Model NS-1 primary trainers which the Stearman Aircraft Company has delivered to the Naval Air Training Station at Pensacola are shown in one of our photographs.

There was a time when a primary training ship used a horsepower of under one hundred and attained a speed of 80 or 90 miles an hour. By contrast, the new NS-1's are equipped with 235-horsepower Wright Whirlwind engines and have speeds which are unofficially estimated as about 140 miles an hour. Naturally, as the speed of our single-seater pursuit ships grows to high figures the training planes have to keep pace.—*A. K.*

Statistics of Aircraft Safety and Use

SOME of the questions frequently asked regarding aviation are: Is private flying progressing? What sort of airplanes are being built? How safe is private flying? How safe is flying on the airlines?

The statistical side of aviation has not developed to anything like the extent of the statistical side of railroad transportation, and these questions are difficult to answer accurately. In the recent Aeronautical Session of the National Safety Council, an excellent and authoritative picture of the situation was offered by John H. Geisse, of the Bureau of Air Commerce, in a fine paper and some interesting charts.

Figure 1 shows the air miles flown during each six month period from the latter half of 1928 to the first half of 1935, the last period for which statistics are available. Miscellaneous flying (that is, private flying, school flying, aerial photography, et cetera) accounted for approximately 80 percent of the total mileage until it started its retrogression. In the first six months of 1935 it still exceeded scheduled flying by about 40 percent, and it is to be expected that this is its all-time low in relation to scheduled flying.

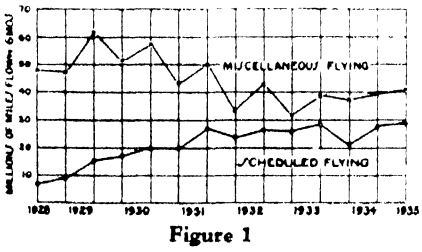


Figure 1

Figure 2 tells a similar story. On this chart are plotted the values of airplane production against years, in non-scheduled, military and transport aircraft. In the gay year of 1929 non-scheduled construction was way ahead, then dropped sharply and is only now beginning to curve upward. The construction of transport airplanes was much more steady and is now sharply increasing.

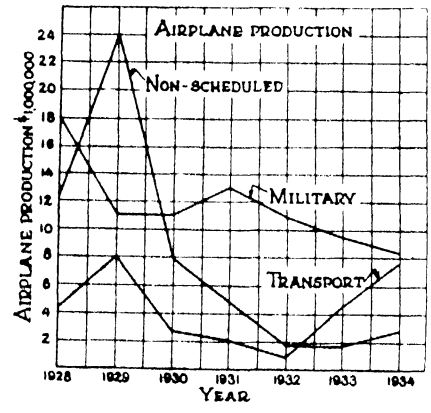


Figure 2

Perhaps Fig. 3 will go as far as anything else to explain the reason why transport flying has forged ahead so much more rapidly than miscellaneous flying. This chart gives fatal accidents due to all causes per 10,000,000 miles down. It appears that miscellaneous flying is many times more hazardous than scheduled flying.

Mr. Geisse attributes the difference almost entirely to airplane characteristics. He maintains that more money and more effort should be spent in developing a safe private airplane. In this he is entirely right. But the difference in safety is not entirely attributable to the airplane. Scheduled flying is undertaken by the very best pilots, with every imaginable aid. Private or miscellaneous flying is undertaken by pilots of the most varied qualifications—some are very good, some indifferent, and some very bad. Miscellaneous flying may be over territory *not* provided with beacons and radio beams.

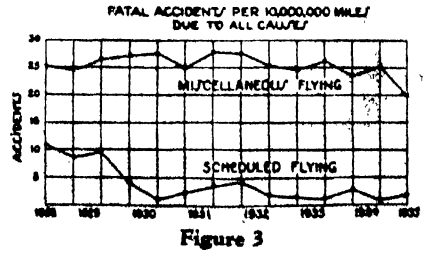


Figure 3

Something also has to be said of cost, which Mr. Geisse's charts do not touch upon. Private flying is an expensive hobby. We are far from the "flivver" airplane. Only real prosperity will spread the means to buy and operate private airplanes. Meanwhile our private airplane manufacturers are not idle, are building as cheaply as the extent of the market will allow, and are never ceasing to improve their product in safety and reliability.—*A. K.*

A group of new high-speed naval training planes

Progress in Two-Row Engines

SINGLE-ROW air-cooled engines in large transport operation appear to be almost as obsolete as four-cylinder automobile motors. Since the 1920's the radial air-cooled engine has been steadily made more powerful by internal supercharging, higher speeds, increased compression ratios, and the use of gasoline with high octane rating. But there was a definite limit to this type of power squeezing. The next step was quite evidently in the direction of twin-row engines.

The single-row nine-cylinder engine seems to reach its limit at a normal rating of 750 horsepower with an allowable overloading to 850 horsepower at take-off. With the latest Twin-Row Wasp, 900 horsepower is normal rating, with 1000 horsepower for take-off. However, if the engine is opened full throttle at sea-level it will give 1150 horsepower for a weight of 1250 pounds, giving a truly marvelous weight-per-horsepower ratio.

Besides offering greater power, the two-row engines have the inestimable advantage of smoother operation because of the more frequent impulses per revolution of the propeller. Thus, in the single row there are 130 heavy impulses per second from a 6¼ inch cylinder; in the two-row there are 250 lighter impulses per second from a 5½ inch cylinder.

Cooling was at first considered a great difficulty in two-row work. But progress in cylinder head finning and in pressure baffling has eliminated the trouble. The cylinder head design consists of cast-on rocker

Plant for recovering pure sulfur dioxide from smelting plant waste gases

boxes and deep, closely spaced cooling fins. The pressure baffles are deflectors between the cylinders which entirely shut off the free flow of air between the cylinders and direct the air completely between the fins. Thus *all* the air which is passed over the engine contributes to its cooling.

Service tests of the twin Wasp have been entirely satisfactory. One outstanding performance has been the flight of 3600 miles non-stop by the Navy Consolidated flying boat from the Canal Zone to San Francisco; others are the repeated transpacific flights of the Pan American Clippers. The engineers have not ceased their efforts, and even greater powers are predicted for this type of prime mover.—*A. K.*

Sulfur Dioxide Recovery

A NEW process, applied in Germany and the Netherlands, recovers sulfur dioxide, the objectionable gas produced as a by-product of many industrial operations, in pure form directly from the dilute waste gases. Sulfur dioxide kills vegetation when allowed to go to waste in the air and hence legal restrictions require that plants producing the gas prevent its escape. Many methods have been used for capturing sulfur dioxide and converting it into useful, salable forms—generally sulfuric acid. However, there is an important market for the gas itself in pure form as the working medium in certain refrigerating systems and for other processes. Hitherto it has been uneconomical to recover the gas itself from the dilute mixtures produced by many industrial operations, particularly the smelting of ores. The new process, called the "sulphidine" process, solves the difficulties formerly met by dissolving the gas in a mixture of xylidine (similar to aniline) and water. This mixture removes sulfur dioxide from even dilute mixtures completely and quickly. When saturated, it readily parts with the gas on heating. The recovered gas is extremely pure and the cost of the process has been found to be low enough for economy.—*D. H. K.*

Bridge Floor Grating

A FEW years ago bridge engineers were startled by a suggestion made by Walter E. Irving, C. E., that open gratings be used as decking on bridges. The traditional idea was that the floor of a bridge should be of solid construction, and the conservatism of engineers kept them from foreseeing the many advantages of an open grating such as that developed by Mr. Irving. Since then, however, this new construction has been used with such complete satisfaction in a number of large bridges that it has taken its place as an important contribution to bridge building.

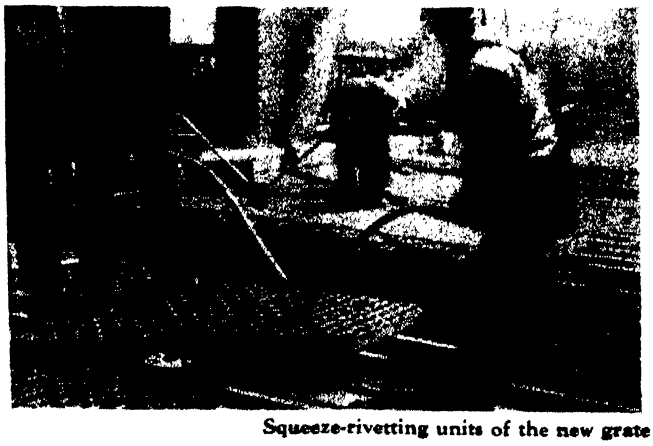
As shown in the accompanying illustrations, Irving decking is very similar to the sidewalk gratings so familiar to all. The interstices are, however, much larger and the vertical thickness considerably more than is usually found in gratings of this sort. Its principal construction feature lies in the fact that it is joined by a patented interlocking process which makes an entire bridge floor, in effect, a single sheet rather than a series of joined panels.

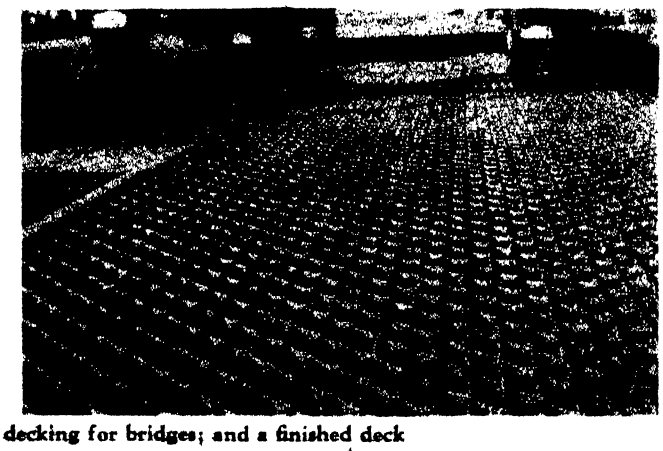
Contrary to first impression, installations of this decking have not worn the tires of automobiles unduly. Its main advantage is, perhaps, its light weight in comparison with heavy, paved floors so generally used. Another extremely important advantage is that at no time does ice or snow accumulate and impede traffic. This last is important when it is considered that on some bridges very great difficulty has been experienced in working out a road surface which will prevent accidents. A notable example of this problem may be seen in one of the New York City bridges over the East River where, despite much study of the problem, many disastrous accidents have occurred in wet or snowy weather. According to reports of those who have studied installations of Irving decking, such accidents will never be caused by the flooring.

Book on Aircraft Diesels

THERE has been so much controversy regarding the aircraft Diesel engine, so much development work carried on in Europe and the United States, that a book on this topic is both timely and valuable. Such a book is "Diesel Aircraft Engines" edited and published by Paul H. Wilkinson. Mr. Wilkinson has been connected with the aircraft and engineering industries since 1911, with experience in England and the United States. He has made excellent use of his knowledge and has produced a book which is eminently readable—semi-popular, semi-technical in outlook, and entirely accurate. In his historical introduction the author points out that the Junkers *Ju 52*, a well known and extensively used airliner is Diesel powered; so are the *Graf Zeppelin* and the *Hindenburg*. These ships are a complete demonstration of the practicability and efficiency of the aircraft Diesel.

We did not realize until we read Mr. Wilkinson's book how many modern aircraft Diesels have actually been developed: In the United States there are the Deschamps 12-cylinder Prestone-cooled rated at 1200 horsepower at 1600 revolutions per minute; the Guiberson 9-cylinder air-cooled radial, rated at 210 horsepower at 2050 revolutions per minute, weighing 509 lbs.; the Packard 9-cylinder air-cooled radial, 240 horsepower at 2050 revolutions per minute, weighing 510 lbs. In England there are the Bristol Phoenix, 9-cylinder 430 horsepower at 2000 revolutions per minute, weighing 1090 lbs., and the Napier Cul-





Squeeze-rivetting units of the new grate decking for bridges; and a finished deck

verin 12-cylinder, with two banks of six vertically opposed cylinders, developing 740 horsepower at 1785 revolutions per minute, weighing 1786 lbs. In France there are the 14-cylinder two-row air-cooled Clerget; the C.L.M. Lille with two banks of 6 cylinders vertically opposed; and the Salmson, another air-cooled engine of 18 cylinders. In Germany there are two Junkers engines (which have been described in these columns), and the Mercedes-Benz, of rugged construction in use in the two large airships. Czechoslovakia is responsible for the ZOD 260-B. Space will not permit anything but mention of these interesting types.

Aircraft Diesels are distinguished from gasoline engines by much higher compression ratios, ranging as high as 17 to 1; much higher specific weight; greater fuel efficiency; the ability to use heavy, non-inflammable fuel oils; direct injection of the fuel spray at a predetermined point of the cycle; and firing of the charge without spark ignition.

Of course, the exponents of the gasoline engine point out that with the liberal use of tetra-ethyl and high octane ratings, the compression ratios and efficiencies of the spark ignition engines have been constantly going up. But the gasoline engines will always involve fire hazards and expensive fuel. However, no theoretical discussion, no laboratory tests, will ever settle the controversy. Only the development of both types and extensive service use will settle the question. In the long run what is most likely to happen is that each type will find its own particular sphere of influence.

Our best thanks are due to Mr. Wilkinson for producing such a concise, interesting, and impartial survey of the whole development. *A. K.*

EMPLOYMENT

WAGES of petroleum refinery workers were nearly 8 percent higher last year than during the boom year of 1929, a study by the U. S. Bureau of Labor Statistics shows. Employment was only 11.9 percent below that of 1929.

Champion Blood Donor

RAYMOND BRIEZ works in the public markets of Paris, but he also has a thriving business of his own. He engages in the manufacture of blood, and since he entered the business in 1924 he has sold 257 quarts.

The output of Briez's human factory—his own body—is enormous when one considers that it takes only 7½ quarts of blood to fill the blood vessels of an adult man. During 1935, Briez manufactured enough blood to supply himself and to give 98 transfusions. Each transfusion averaged about 10 ounces. Last year broke all his previous sales records.

The champion blood donor of Paris started his manufacturing business in a small way. In 1924, he gave blood for four transfusions. The next year his orders jumped to 38. In 1927, the number of transfusions supplied by him attained the astonishing figure of 94, and from that time until 1935 he averaged from 50 to 60 a year.

No ill effects have been noted, and Briez

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For tens of thousands of miles, in millions of automobiles, the metal pipes that carry gas and oil withstand the vibration of high speeds and the jolts of rough roads. They are stronger, they last longer, because of electric-furnace brazing. Sealed in millions of electric refrigerators, vital parts made by this process keep the mechanism operating quietly, efficiently, year after year. The greater strength that comes from brazing means more dependable service for you, and fewer repair bills.

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Electric-furnace brazing—a process that causes copper to penetrate deep into pieces of harder metal, joining them into a solid whole—was developed in the General Electric Research Laboratory, in Schenectady, N. Y. And when G-E research gave industry this improved manufacturing method, it was saving industry—and you—millions of dollars in the cost and maintenance of manufactured products.

G-E research has saved the public from ten to one hundred dollars for every dollar it has earned for General Electric

GENERAL ELECTRIC

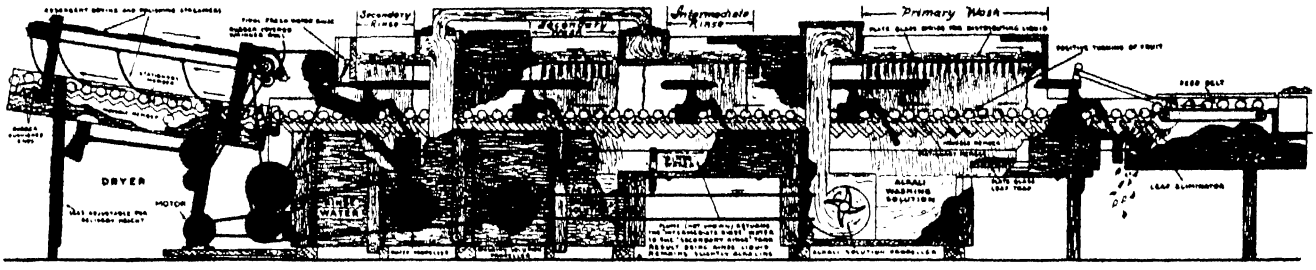


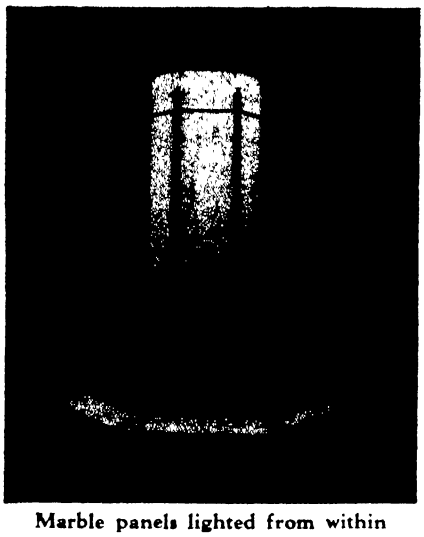
Diagram of a machine for removing spray residues from fruit, showing the several stages of the process

is always ready for another call, according to the Paris correspondent of *The Journal of the American Medical Association.*

Translucent Marble

A NEW marble, christened Lumar, which attains a high point of light-transmission and in which sub-surface beauties of color and texture appear in spectacular fashion, is the outcome of a long period of intensive research into the crystal formation of various types of marble. Of the six varieties of Lumar which have resulted, Lumar Yule, developed from Colorado's own marble, has the most brilliant light intensity.

The objective of the study of the calcite crystals of which marble is composed was



Marble panels lighted from within

to determine the types of marble in which the structure was especially adapted to the transmission of light. The ability of these crystals, which are the same type as those used in optical instruments, to transmit light varies with the direction of the incident beam. The task of the research, therefore, was first to select the proper marbles, and then to evolve a method of processing them which would make the most advantageous use of their individual characteristics. The details of the process are, for the present, a closely guarded secret.

Lumar transmits light in varying degrees of intensity and at the same time discloses in all the vividness of their natural beauty the wide variety of colors and veinings which lie within the solid marble.

Poison Spray Removal

FEAR of poisoning from the tiny residues of lead and arsenic left on fruit by the sprays used to protect it from insects has encouraged the development of better and better methods for removing these poisons. Methods now standard in the fruit industry include washing with weak hydrochloric acid solutions or solutions of water glass. However, the waxy coating on apples and pears holds traces of these poisons on heavily sprayed fruit that cannot be removed completely by ordinary methods. R. H. Robinson, of the Oregon Agricultural Experiment Station, reports in *Industrial and Engineering Chemistry* a new method of making such fruit safer to eat by supplementing the ordinary treatments with a wash of petroleum oil. This solvent dissolves the waxy layer and allows the other treatments to take effect. Federal regulations place the maximum permissible amounts of lead and arsenic trioxide at 0.018 and 0.010 grains per pound of fruit. The danger from such poisons is that they accumulate in the human system and may ultimately build up dangerous concentrations if one eats poorly washed fruit.—*D. H. K.*

Weather Map in Three Dimensions

A NEW type weather map showing meteorological conditions in three dimensions to an altitude of 16,000 feet has been developed by I. I. Zellon, of the United States Weather Bureau in Pittsburgh.

Mr. Zellon's device consists of a small box holding eight glass plates slightly separated. Each plate represents 2000 feet of height, while the basic ground map below the plates is an outline of continental United States.

The new development is helpful in the plotting of upper air weather information obtained by pilot balloons, army airplane flights, and the weather data supplied by airline pilots. This new system of taking weather information is known as air mass analysis because not only are ground data taken but also the nature of a cross-section of the upper air is determined.

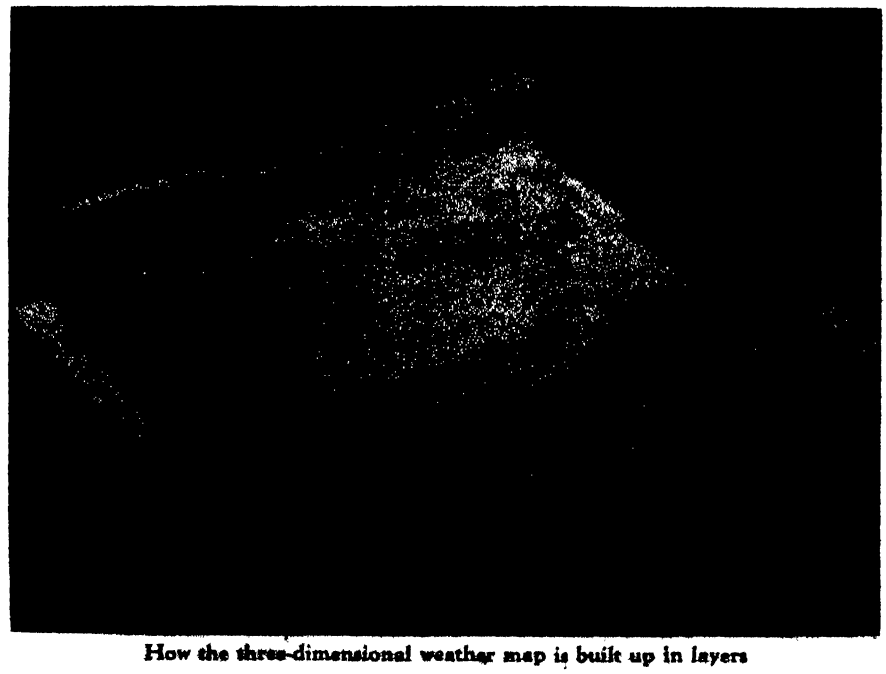
Fast-drying opaque inks of different colors are used for plotting the various aerological data; wind velocity may be red, pressure blue, and so on.

Says the government weather scientist: "The meteorologist will find that he can rather quickly plot on these panes the data from the pilot balloon and airplane stations, adding the analysis of fronts and air masses, for each 2000 foot level. By looking down through the series of plots a graphic picture of the synoptic situation in three dimensions can be gained. Although this gives a somewhat cruder representation of the upper air, in some respects, than a carefully drawn cross-section, it has the advantage of giving three dimensions rather than two, and of being more legible and intelligible to one not a technician in modern aerological analysis. Airplane pilots in particular can learn to read more readily from the mapping frame than from the ordinary surface map or cross-section the information they wish to know; it should be better in this regard than a series of upper air maps laid side by side, if the glass frames be large enough, well drawn, and properly illuminated."—*Science Service.*

Bearded Lady Refeminized

THE first operation on the pituitary gland performed in the hope of refeminizing a bearded lady was reported by Dr. H. Lisser of the University of California Medical School at a recent session of the Association for the Study of Internal Secretions.

Similar operations have been performed



How the three-dimensional weather map is built up in layers

for the removal of adrenal gland tumors which had been the cause of virilism.

The operation reported was successful for the first year. The patient lost her beard and other symptoms of the pituitary disorder from which she suffered, following removal of part of the pituitary gland.

During the second year after operation the beard grew back and some other signs of the original condition reappeared. A tumor was found in the part of the gland removed.—Copyright 1936, *Science Service.*

New Uses For Pitch

PITCH has been found to serve as a highly satisfactory powdered fuel for the direct firing of rotary lime kilns, says *Chemical Trade Journal.* The pitch is marketed in the form of flakes, produced on rotating cooled drums or on moving water-cooled metal belts.

Another use for pitch has developed with the recent installation of several thousand miles of steel pipe for conducting gas, requiring coatings for protection against corrosion. Coal-tar pitch has been used in large quantities by pipe-layers.—*A. E. B.*

CATARACT

MANY young and middle-aged women who have taken the dangerous fat-reducing medicine, dinitrophenol, have developed cataract of the eye.

Animals' Ears More Efficient Than Best Man-Made Microphones

QUANTITATIVE measurements on the ears of guinea pigs show the animal ear to be a far more effective microphone than those constructed mechanically, according to Professors Ernest G. Wever and Charles W. Bray, of the Princeton University Department of Psychology.

Small currents arising in the cochlea of the inner ear and measured on an oscillograph provide an accurate measurement of the response of the animal to sound, and the results of recent experiments show that the animal is capable of responding to tones of a wide range of frequencies, even though these tones be quite faint, whereas it is a well-known fact that mechanical microphones must sacrifice either sensitivity or range.

That this electrical method of measuring sound effect is accurate was determined several years ago when the small currents were amplified about half a million times and run into a telephone receiver. It was then possible for one person to talk to the animal and another person in a distant room not only to recognize the words but the voice of the speaker.—*Science Service.*

Where Ice Cost is No Item

ACCORDING to the United States Bureau of Dairy Industry, the ice-well method of cooling and holding cream on dairy farms proved a good investment in the Northern Great Plains area last summer. To construct an ice well, a hole approximately 9 feet square and 9½ feet deep is dug on a well-drained location convenient to the milk room and the water supply.

Others claim Mildness Philip Morris proves it

Philip Morris Cigarettes offer you a completely new kind of mildness—a mildness achieved by a special manufacturing process exclusively Philip Morris.

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✓ *Philip Morris & Company do not claim that Philip Morris Cigarettes cure irritation. But they do say that an added ingredient, a source of irritation in other cigarettes, is not present in Philip Morris.*

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Trophy for Diesel inventions

Small- to medium-sized stones are set in the bottom to a depth of 1½ feet. Two-by-four studs are placed two feet apart against the earth walls. Cheap unmatched lumber nailed to the studding gives an ice storage space approximately eight feet square and eight feet deep. A small structure is built over the well—the floor in sections to facilitate removal—to allow free circulation of cold air when freezing the ice block in winter.

On the arrival of cold weather, water is sprinkled on the stones until a solid bottom of ice gradually freezes in the well. Snow and water may be used at the start if snow is available. Freezing the bottom of the ice chamber cannot be rushed as adding too much water at one time will melt the thin layer of ice in the bottom and allow the water to escape through the stones. Adding the water in thin layers and frequently on good freezing days and nights gives the most satisfactory results.

A 6½ foot block of ice in the well will leave room for a five-gallon cream can between the top of the block and the floor. Experience shows that an ice well, opened for use in May, will last well into September or October. *Journal of the Franklin Institute.*

Prize Offered for Diesel Invention

INVENTORS with inclinations toward Diesel engines are given encouragement through the offering of a 1000-dollar cash prize for the best Diesel invention submitted before midnight, April 30, 1937. A perpetual silver trophy has also been offered on which each year's winner's name will be inscribed. The thousand-dollar prize and the Diesel Inventors Trophy will both be given by Mr. Ralph Hemphill, president of the Hemphill Diesel Engineering Schools, Inc.

It is anticipated that during the next five years there will be as rapid development in the Diesel engine field as there has been in the gasoline engine field during the last 20 years. Such being the case the offering of a prize of this value for the most outstanding improvement in the design, accessory or testing equipment of a Diesel engine, will foster the efforts of many engineers and laymen that might not otherwise take an interest in the Diesel.

REBIRTH

A CAT may have nine lives but one butterfly, the gold-banded skipper, is born seven times. It actually passes through six metamorphoses in its progress from the almost microscopic egg to the adult insect, each stage having its own peculiar physical structure, color, and way of life.

Vacuum Grass Seed Harvesting

AGRICULTURAL engineers and agronomists of Kansas State College, cooperating with the Federal Soil Conservation Service, have recently developed and tested an experimental machine for harvesting buffalo grass seed. Resembling, in principle, a mammoth vacuum cleaner, the machine sweeps the native buffalo grass sod, picking up by a strong suction the seeds imbedded in the short grass.

The importance of the machine lies in the fact that buffalo grass has proved itself an excellent land covering in the plains states for protecting the surface against water and wind erosion. The greatest drawback has been the slowness of propagation of the grass. It is propagated by roots or by setting out pieces of sod which will send out runners and slowly cover the surface. This method of sodding is both slow and expensive. It was the hope of the Soil Conservation Service that the grass could be propagated by seed and this necessitated a machine to harvest the seed.

The apparatus developed consists mainly of a large engine-driven suction fan mounted on a trailer. The seeds deeply imbedded in the turf are picked up by a suction nozzle connected to the fan by a flexible tube and running close to the ground. A tube on the discharge side of the fan carries the seed to a dust collector and bagger. The material picked up by the machine and caught in bags consists of seed and large amounts of dirt and other foreign material. By cleaning the material with a common fanning mill, a final product containing about 50 percent seed can be obtained.

Tests with the experimental machines gave 95 percent efficiency in harvesting buffalo grass seed from a pasture previously clipped with a mower. Where the grass turf is not too dense, efficiencies of from 50 to 70 percent were obtained without the aid of a mower.

Antidote for CO Poisoning

TESTS made by Sam and Joseph Seifert, of the University of Oklahoma School of Medicine, indicate that a compound made from ferric chloride and hydrogen peroxide may be an effective antidote for carbon monoxide poisoning. The compound, hexahydroxyferric chloride, showed 75 percent recovery when injected into rats suffering from carbon monoxide poisoning, according to a report made by these investigators at a recent meeting of the American Chemical Society. Results are encouraging although not yet conclusive.

The deadly effect of carbon monoxide is produced by the combination of this gas with the hemoglobin of the blood to form a compound which is not easily broken up by oxygen and which prevents the blood from carrying life-giving oxygen to the various parts of the body. Many treatments of this form of poisoning have been partially successful and the search is being continued for a sure antidote.—*D. H. K.*

New Non-Poisonous Insecticide

ELIMINATION of the hazard to health resulting from spraying poisonous insecticides on fruit and vegetable plants is promised by the discovery of a new, effective insecticide known as phenothiazine.

A large number of organic materials have been investigated by the Bureau of Entomology of the Department of Agriculture and at last one has been identified which apparently is just as good an in-

Buffalo-grass seed is harvested efficiently with this "vacuum cleaner"

secticide as lead arsenate but offers none of the difficulties of spray residue. This material is phenothiazine, an organic chemical compound synthesized from easily available cheap chemicals by an inexpensive process.

Phenothiazine is manufactured by fusing together one part of diphenylamine with two parts of sulfur at 180 degrees, Centigrade, using iodine as a catalyst. The crude product may be purified by recrystallization from toluene. It is a light yellow crystalline powder which melts at about 180 degrees, Centigrade, neutral in reaction, insoluble in water, and only slightly soluble in cold oil or the usual organic solvents.

This new compound is applied as a dust for dry treatment if desired; but the preferred application is a suspension in water containing a wetting or adhesive medium.

Phenothiazine is non-toxic to man and to all warm-blooded animals. This means that the agricultural user has no problem of preventing stock from access to foliage or fruit which has been treated. If the stock eat such material there is no harm. If there be any residue of the spray on the fruit or vegetable reaching the canner or the home kitchen, there is no danger in this.

If the new insecticide proves even half as good as anticipated, it is likely to supplant the metallic type of insecticides within a year or two. *A. E. B.*

SKIN PROTECTION

THE coloring matter of the skin provides an anchorage for scurvy-preventing vitamin C and the vitamin, in turn, protects the skin from injury by harmful light rays.

Color Filters in Windshields to Help Color-Blind Drivers

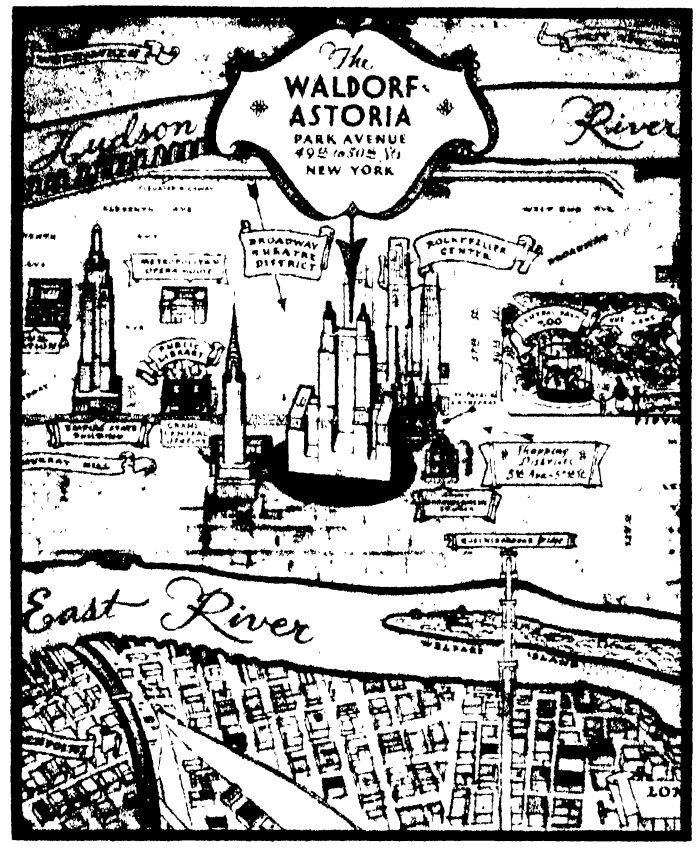
A SIMPLE and "infallible" help for the color-blind automobile driver who gets into difficulties because he cannot distinguish between green and red traffic lights is suggested by Thomas Ross of the University of Washington. In a report to the magazine *Science*, Mr. Ross describes a contrivance that can be fitted to the wind-shield of the color-blind driver's car.

The device consists of small pieces of special glass which can filter out either red or green light. With the red filter placed above the green one, the driver will know that when he sees a light through the top piece of glass he is seeing a red light. When he sees the light through the bottom piece in this arrangement it is a green light. The device is improved by placing a prism over each filter in such a way that the traffic signal will be visible through both filters at the same time.

This idea has worked in actual trials, Mr. Ross reports. It could be adapted to persons suffering from other types of color-blindness besides the red-green kind. A variation of the red and green filters is also suggested. One of the color filters, says Mr. Ross, might be perforated and parts of the other set in it like polka dots.

"Thus, if the red filter were perforated and the openings were filled with the green material, a red traffic light or other red ob-

(*Please turn to page* 50)



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Conducted by ALBERT G. INGALLS

LAST month we described a telescope having a sufficiently rigid mounting to stand up solidly against all sorts of outside forces which cause telescopes that have whippy mountings to vibrate and shimmy, and now we show a photograph of another which meets with the same requirements and, incidentally, is a very fine job. It was made by Alan Gee, 2969 Upton St. N. W., Washington, D. C., and C. Carvel Diller, 1423 Buchanan St. N. W., the same city. It is a 12½" instrument and has a solid 3" polar axis. Asked for a description of this unusually fine job, Mr. Gee writes: "The telescope is a 12½" Newt-Cass combination of 57" primary focus and 150" secondary focus. This telescope is a good example of what can be accomplished by co-operation among amateurs. Mr. Diller made the mirror, his first one, but had never made any mountings. As I had had considerable experience in mounting making, I designed the mounting for him. We then constructed it together, the work requiring about a year and a half.

"The telescope has a synchronous motor clock drive, as well as electric fast and slow motions, push button controlled. The electric drives, which I constructed myself, are all ball bearing equipped and operate perfectly. All polar axis motions work through the same drive gear, using a differential for the slow motion and an electric clutch for the fast.

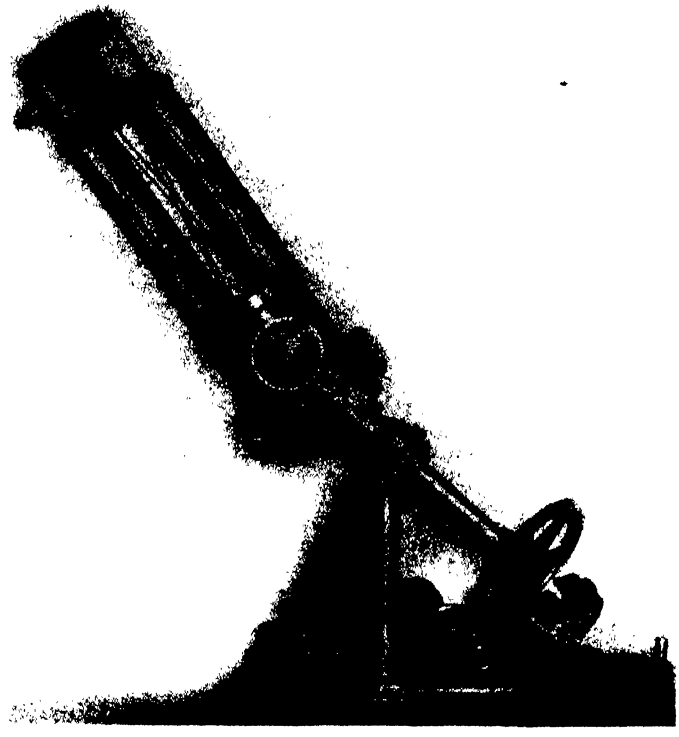
"Interchangeable sleeves for the tube are used for the Newt-Cass transfer. There is no hole in the mirror, so a lower prism is used. The telescope is very rigid and easily controlled.

"Any other amateurs wishing more information about this telescope can obtain it by writing to me."

And Mr. Diller writes: "I am employed in the Glass Section of the National Bureau of Standards and, being associated with experts in optics and engineering, I became interested in astronomy and then in building the telescope. I consulted with Dr. Ritchey, the well-known telescope builder, and my instrument is of the fork type mounting similar to that used by him on the 40" 'scope that he built for the U. S. Naval Observatory here.

"I ground and figured the 12½" mirror by hand, doing the work evenings and in my vacation periods over a time of about five months. I also had the use of a machine shop and the machine work was done nights and Sundays over a period of one year. The patterns and castings for the forks, bearing mountings, and uprights were made by local firms and the large 20" driving gears, as well as the other various gears and worms, were purchased from the Grant and Boston gear works.

"The synchronous motor drives the polar axis through a 20" worm gear. One motor drives for fast, the other for slow motion, through the same 20" gear, by using a differential for one and an automatic clutch for the other. There is a motor drive for declination, and all motors are controlled through a push button unit which is carried in the hand by the observer.



The Diller-Gee, 12½-inch Newt-Cass telescope

"The instrument may be used as a Newtonian or Cassegrain by interchanging the top sleeve, one sleeve having a prism for the Newtonian, the other for the secondary. With the assistance of the Rev. Dr. Sheehy and Mr. Ernest Valada I obtained permission to mount the telescope at the Catholic University."

Data on the clock drive of this telescope will be included in "A.T.M.," Vol. II, the renamed "Supplement."

OLD stereopticon lenses make good finders for telescopes, according to Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alta. "I bought one cheaply in a second-hand store," he states, "and discovered that the front combination was semi-achromatic, covered a very wide field and gave lots of light. With a cheap 1" eyepiece and No. 40 cross-wires it makes a splendid finder. There must be thousands of these old lenses on the market. Remove the rear lens, solder a tube on the back of the mounting, and focus by means of the rack and pinion already found on the lens. Such groups as the Pleiades look fine in the finder."

Readers often inquire what use to make of such lenses, and here is the answer.

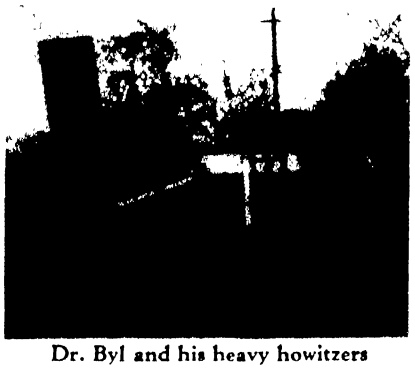
AN English firm (Watson) advertises an odd but interesting stunt: a 15" single lens hung in a front window. "If the observer is 6' from the lens the distant objects appear enlarged 1½ times, and the greater the distance of the observer the greater the magnifying power of the lens. One may recognize the visitor far down the drive and, if desirable, establish an alibi in time, also watch birds and so on." It ought not to be difficult for the amateur to fix up something similar. It wouldn't be achromatic, but probably would distinguish a bill collector in time.

A WRITER in *Nature* suggests that the unsteadiness of the images so often given by reflectors arises largely from the fact that their mirrors are so near ground level where the air is disturbed by temperature differences. As refractors generally give steadier images than reflectors, this is a point to reckon with. The mirror lies closer to the ground than the objective of a refractor. In past generations acres of paper have been covered with published arguments about the superiority of the reflector over the refractor, though many reflector owners concede the point to the opposition, in their franker moments. But it is easier and less expensive to build a fair-sized reflector.

WAY back in prehistoric days, when the telescope making hobby was evolving from the ape stage, we published (Feb. 1929) a letter from Dr. J. J. Byl, 430 S. 13 St., San Jose, Calif., describing his telescope, and in it he wrote: "I am a retired physician well along in years but have great anticipations of joy in so profound a study as the boundless Universe, and I am sure that my days will never be shortened by a loss of interest in life." At that time he had already made a 10" and a 12" telescope. Seven years have gone by and here is what we now hear about the same Dr. Byl, written by Ralph Dietz, 330½ S. Fifth St., San Jose. "I enclose a picture I took of Dr. J. J. Byl and some of his many 'scopes. He is a rather elderly man and all he lives for is to build telescopes. He has on hand, that I know of, two 12", four 10", several 8", one 15", and 'The Howitzer' or 22". The photograph shows the last named two. His mind is running on all six and he will try anything once." (Photograph on opposite page.)

And so Dr. Byl's own prediction very happily turned out to be true. So far as we know, this 22" is the largest amateur's telescope, though Hindle is now building a 30". No doubt when Dr. Byl hears this he will tackle a 31"!

WITH so much amateur talent constantly dwelling on every corner of optics—and having what the professional lacks, namely, the leisure time to think—the whole ground is continually being gone over and over, like a hungry monkey in a cage hopefully pawing over the straw for a few uneaten peanuts. The special ground covered by *tests* seems to be exploited the most, with the result that new tests are



Dr. Byl and his heavy howitzers

being found, and old tests which have been lost sight of or never learned of are being dug up, often several times and independently. An amateur who independently discovers a valuable test which other amateurs or else professionals have long since used, usually feels but little cheered upon being told that, anyway, the high regard with which it has been held "for the past century or two" does flatter his judgment in developing it independently. Every little while, for the past decade, a report of a newly discovered test has been sent in, and it takes courage to reply to a man who believes he got there first that the discovery, even if original, is not the first. Of course, the standing rule in science is that the first fellow who *publishes* gets the credit. Often this works hardships, but it also helps forestall arguments.

There are tests and tests. Some are of major importance while others are of lesser though considerable importance. In a few instances workers have claimed invention or discovery of things that seemed almost self-evident—though the ones to be described below are not to be thought of in that light. Hundreds of other inventions have been re-invented several times. Recently we read of the invention of the safety pin in the last century. But MacCurdy's "Human Origins" shows pictures of safety pins, almost identical with our common modern diaper pins, from Bronze Age deposits in Greece. The invention was evidently lost, and re-invented in the last century. The power loom, metal pens, and many other things were invented long ago, forgotten and then re-invented. But all of this is not meant to discourage amateur opticians from reporting their original ideas, whether they turn out old or new.

Last year, on July 12, Floyd L. Frazine, 868 Central Ave., St. Petersburg, Fla., suggested testing a convex surface by means of interference fringes between it and a concave test plate. Thirteen days later Wilbur Silvertooth, 273 Ximeno Ave., Long Beach, Calif., independently suggested making "a concave master, using the tool for the final convex secondary and figuring to appear flat in conjunction with the test mirror; then polishing the concave and figuring by checking on the concave master until the fringes are straight. But," he

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Fourth Edition
Revised
Autumn, 1935

AMATEUR TELESCOPE MAKING

The Reflecting Telescope
Tools and Materials
Foucault's Shadow Test
Polishing the Glass
Final Shaping
Finishing Touches
Mounting the Mirror
The Refracting Telescope
Grinding the Lens
Testing and Refining
Mounting the Lens
Adjusting the Telescope
How to Find Celestial Objects
Telescope Housings
Theory of Eyepieces
Types of Eyepieces
Making Eyepieces
Design Principles of Mountings
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Making a Spectroscope and Spectroheliograph
Making Compound Telescopes
Making Optical Flats
Making a Sun Spectroscope
Photographing with the Telescope

And a "miscellany," being a 200-page mine of useful information, mainly practical, based on amateurs' actual difficulties, concerning 1001 aspects of amateur telescope making, and containing a multitude of hints, wrinkles and suggestions on grinding, polishing, testing and shaping. This part includes minutely detailed 30-page instructions for silvering glass, which leave nothing to the beginner's judgment.

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added, "I have learned, since having this idea, that all Cass secondaries by Zeiss are figured by interference against standard masters." Largely on account of the last statement publication was put off, and last March J. V. McAdam, of Hastings-on-Hudson, N. Y., wrote that he had figured out a way to short-circuit hard work: "Fine grind the convex with a concave, polish the mirror, lay it on the tool and observe the interference fringes through the tool." The same general idea.

Well, this makes three who have independently thought of this method, and it is too bad it proved to be an old one. Perhaps other amateurs can give them a cheer, anyway; it isn't their fault that they were born 30 years too late! Still further, Ellison comments: "I too have found that it is not difficult to test Cassegrain convexes from the back, treating them as concaves. There is an error, but it is not great, and can be allowed for." And Hindle: "I have never used this method, on account of the danger of scratching the surface, but I believe the system is extremely old, and in very general use amongst manufacturers for checking the curvature of convex lenses."

A similar case of independent discovery was that of Joseph E. Boehm, 3511 N. Seminary Ave., Chicago, who tested a 14" perforated primary against an 11" flat placed inside the focus. His letter was referred to Hindle, since the latter was known to be especially interested in tests, but without knowledge on our part that the same test had actually been published by him in *English Mechanics* (April 20, 1923). Another case of independent discovery. Boehm found the test invaluable to short focus mirror workers, he states.

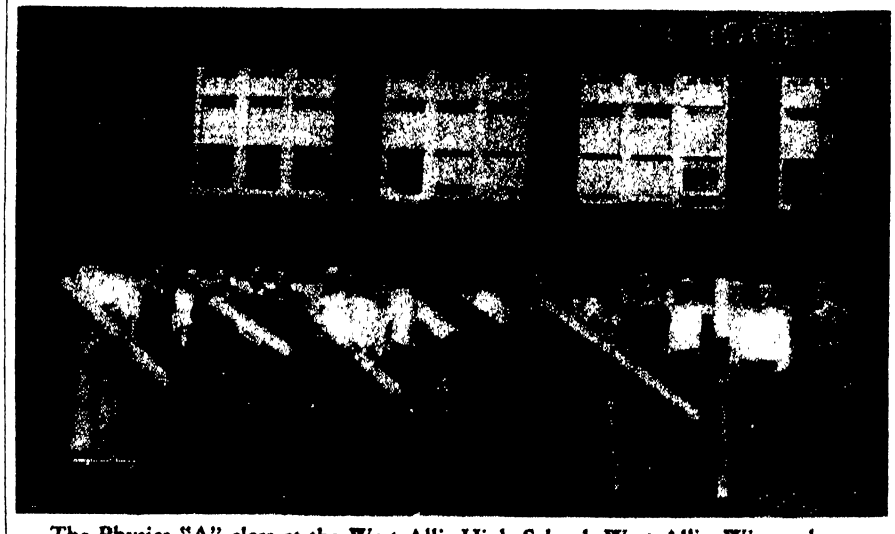
Several amateurs discovered different ways to make the Ronchi test quantitative, but it now looks as if Ronchi himself published the first method. If we could read Italian we might be more certain about it.

About 1933 Alan R. Kirkham suggested a test in which the pinhole is placed at the focus of a paraboloid, the rays being reflected as parallel rays and received by another paraboloid, then brought to a focus and cut by the knife-edge. This was published only as a multigraphed sheet which not everyone saw, and in 1935 William Mason of Lorain, Ohio, proposed exactly the same test. Even then we failed to publish it, and later that year James Hart Wyld of Princeton University made the same proposal. By that time Kirkham had actually tried it and, when shown Wyld's letter, he wrote, "This is my test, but I'll be darn glad to give it away; I don't remember who gave it to me or I'd kill him. The main trouble is collimation, also diffraction effects." We did not publish this, and not long afterward S. H. Sheib of Richmond proposed the very same test. That makes four separate optical geniuses or else one optical genius and three geniuses in mind reading.

We now publish these various notes on tests in order to forestall others who may be devoting good time to the re-invention of these earlier ideas, but not, however, to discourage anyone from discovering an important new test which would add to the prestige and standing of the amateur telescope maker and be an aid to science.

MANY different dodges have been worked out to avoid spending long hours in polishing telescope mirrors. J. J. Stoy, 501 City Hall, Atlanta, Ga., states that he polished a 12½" Pyrex mirror in less than 9 hours, by using a suggestion of another TN, Mr. H. E. Bussey, in his city. "Settle No. 303½ for 60 minutes, first stirring it thoroughly. Siphon off the water. Settle 24 hours and dehydrate. Mix the residue in 3 tablespoonsful of water and 1 of glycerine, to neutralize the evaporation effect as far as possible. Grind in 10-minute wets, alternately with mirror and tool on top. Mix the water and glycerine before putting in the emery; otherwise, trouble."

TO answer those who inquire about the new book (Supplement, or "A.T.M.," Vol. II) on which we are still working, and ask when it will be ready: at present (May 28) about a score of major contributions are in and "ready for printer." Three still remain to come. Hence it is yet impossible to name the date.



The Physics "A" class at the West Allis High School, West Allis, Wisc., where telescope making is used as project work to create added interest in light and optics. It proved possible for each member of this class to make a 4-inch telescope at a cost of but $1.25. Each telescope was different from the others, and was made largely from pick-me-ups. A motion picture film of grinding, polishing, and testing telescope mirrors is available through H. R. Stamm, of the Science Dept.

CONVENTIONS of amateur telescope makers and astronomers: At the Harvard College Observatory, Cambridge, Mass., Saturday, July 18, sponsored by the Amateur Telescope Makers of Boston, Arthur G. Hall, Sec., 63 Commonwealth Road, Watertown, Mass. At *Stellafane*, near Springfield, Vermont, Saturday, August 8, sponsored by the "mother club," The

A *Science Service* photograph of Leonid Surodeikin, worker at the Leningrad Optical Institute, U. S. S. R., preparing equipment to be used in the July eclipse. Data about the job being done are not given, but a thin glass disk is obviously being polished on a typical pitch lap

Telescope Makers of Springfield, R. J. Lyon, Sec., Springfield, Vt. Anyone who is a telescope maker or only an amateur astronomer is cordially invited to come to these open, informal conventions.

New organizations: Amateur Telescope Makers of Spokane, R. H. Dellar, Sec., 1017 Cedar St., Spokane, Wash. San Diego Astronomical Society, James T. Hyatt, Sec., 4041 Oakcrest Drive, San Diego, Calif.

New publication: Astronomy Club Bulletin, Saint Lawrence University Astronomy Club, Canton, N. Y. Entirely astronomical.

Exhibition: International Astronomical Exposition, Sociedad Astronómico de España y América, Señor Don Federico Armenter de Monasterio, Secretario General, Calle Cortes 573, Barcelona, Spain, in October. R. L. Beardsley, 2515 W. 21 St., Los Angeles, Calif., who is a member of this organization, states that the society wishes to get in touch with American amateur societies and supply dealers who will exhibit. Leo J. Scanlon, 1405 East St., Pittsburgh, Pa., plans an exhibit and is open to suggestions regarding material, which is to be sent to Spain Aug. 1.

Summer school of astronomy: Harvard College Observatory, Cambridge, Mass., July 6-Aug. 15. "The elementary aspects of astronomy are by no means neglected. It introduces the student to the variety of astronomical instruments."

One hundred amateurs wanted, once and for all time, to verify or destroy claim that a 6" telescope can "read a watch at half a mile." Send reports to Exaggeration Dept., in care of Ye Olde Scribe, this magazine.

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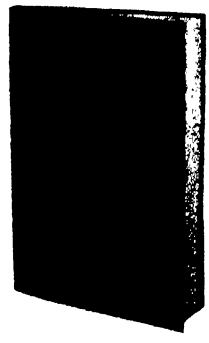

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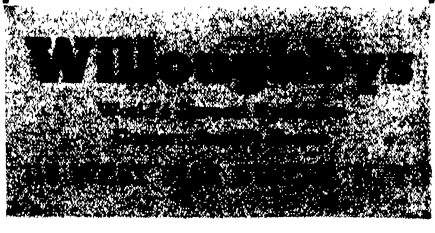


CAMERA ANGLES

Conducted by JACOB DESCHIN

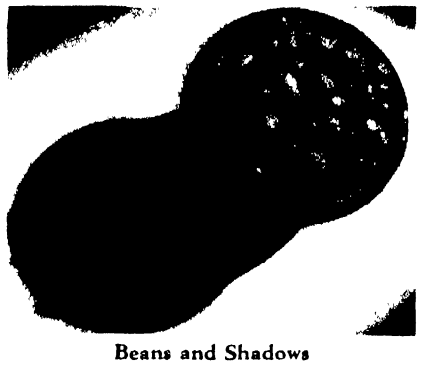
Things To Eat

THE photography of objects gastronomic is not necessarily the monopoly of commercial workers. They often do a beautiful job of picturing a salad, a cake or a pair of chops, but often, too, the performance is a very poor one. So let not the hobbyist balk at what appears to him to be out of his range. If he composes his picture properly, places the light or lights at a suitable angle and uses the right kind of film he has nothing to fear. It must not be overlooked, also, that part of the effect of a well-made commercial food picture is the subject itself, which in most cases is made up and arranged by a chef or cook specially schooled in the arts and wiles of tickling the human appetite via the eye.

Personally, however, it is the feeling of this department that no masterpiece of a head chef of the most regal restaurant in existence can beat the appeal of Johnny taking a first bite out of a slice of bread well covered with jam, the first cut of a freshly baked lemon meringue pie, a basket of eggs just in from the farm, a pot of beans, or whatever you may be having for supper tonight. Yours truly once whiled away the time it took to cool a bowl of soup to a reasonable temperature for eating purposes by taking a picture of it, which is, incidentally, one way of having your soup and eating it, too.

The principal requirements of a good food picture are that it should show texture and form, have a range of tones sufficiently long to reproduce the subject adequately and that it should have an appetizing, "mouth-watering" atmosphere about it. It should look real, "good enough to eat." Lighting for texture is merely a matter of directing the beam at a cross angle so that the smallest detail will throw a shadow. Thus, in the picture of the bread reproduced here, a spotlight was used, the beam being directed at the surface at such an angle that the light just "grazed" it.

In the case of the pot of beans and "Three of a Kind," cross-lighting would be no advantage since, the objects being round and smooth, there is no texture to record. Good general lighting at the normal 45-degree angle will serve to give full illumination for the subject as a whole as well as to create the highlights that give roundness and form. In making the picture of the beans a spotlight was used to throw the shadow of the pot and a weaker general light on the other side to "fill in" the shadows of the beans to some extent. As to

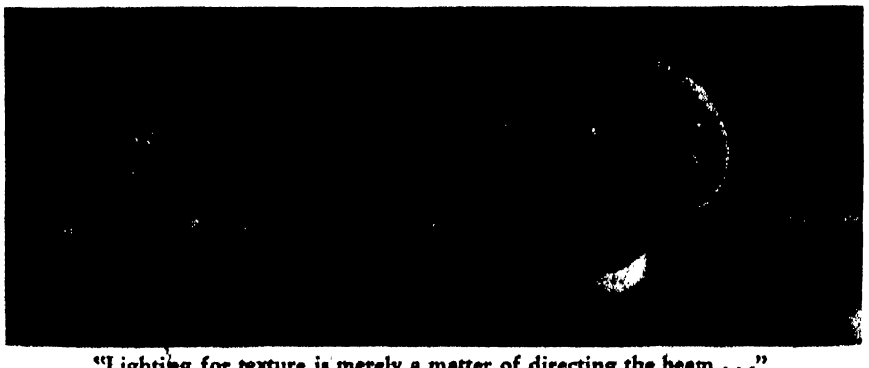


Beans and Shadows

choice of film: for purposes of contrast it is best to use orthochromatic, but where fuller color correction is required, as when reddish tones are to be included, panchromatic film should be used. Choose the slower speed when using the latter as it will give better contrast than "superpan." The "slower" film will not be a drawback as most food pictures that you take will probably require time exposures.

Inasmuch as reproduction of photographs by the half-tone process, and the reduction in size to fit the columns, necessarily degrade print contrast quality to some extent, the illustrations are not to be considered as exact reproductions of the originals.

In general, you will find that in food



"Lighting for texture is merely a matter of directing the beam . . ."

Three of a Kind

photography the most important thing is lighting, for which reason you will probably do more experimenting indoors, where you can direct the light as you will, than outdoors. However, the outdoors is not to be neglected, as at certain times of day, in the morning and later afternoon, you will find on farm and city market-places ideal lighting conditions for many food subjects.

Stirring Rod Rack

A CONVENIENT arrangement for keeping thermometers and stirring rods so that they are quickly accessible when required is a rack through which a number of holes have been drilled with a circumference large enough to accommodate the various items. This rack should preferably be fastened to the darkroom wall so that its location is definitely established. It may consist simply of a strip of wood to form the shelf, through which the holes are bored. The shelf should be supported by brackets or appropriately thick pieces of wood at each end and another shelf attached below it at a distance a bit more than half the length of the rods and thermometers. An arrangement like this will be particularly useful for storing the glass type of thermometer that seems so often to become accidentally broken because there is no place for it. Also, it will obviate groping about for rods and thermometers when they are most urgently needed. And last, but quite important, it's a neater business all around than having these gadgets lying about loose with no place they can call home.

Camera Money

"YOU tell us everything except how to make money with our cameras," one of our readers once remarked to this department. In an effort to repair this omission, this department replies that the ability to make money with a camera is dependent to a large extent on a more or less thorough comprehension of what editors of magazines and newspapers want. You can get a pretty good idea of this by studying the particular magazines or newspapers to which you wish to submit your pictures. Sunday supplements and rotogravure sections in your own or neighboring town or city are the best prospects to aim for. News pictures, unless you happen accidentally on a scene of real news importance and can get it to the newspaper fast enough, are not worth bothering with as news cameramen are pretty alert people and you would have to go some to compete with them. You should keep to the feature type of picture which can be used almost any time. Freak pictures, unfamiliar places about town beautifully photographed, cute baby pictures, odd hobby pictures, unusual winter scenes, are some of the types in demand. There are a number of juvenile weeklies throughout the country that accept short articles of successful young people together with a characteristic photograph, and other magazines buy photographs without articles, though these must be well captioned.

In addition to publications, there is the contest field. A variety of worth while prizes are offered for good photographs submitted by amateurs; advertisers are always in the market for fine baby pictures to use in their advertisements; post cards of scenes about town can be sold to visitors and townsfolk, and many avenues will open to the amateur who makes an effort to do a little pin-money "business" with the neighbors. Many a person who wouldn't dare step inside of a professional studio will gladly "sit" for the amateur.

The prices paid by publishers vary from about 50 cents to five dollars, with three dollars being about the price paid by the papers of medium circulation. The juvenile weekly magazines pay from one dollar to two dollars. Editors demand glossy prints because they feel these reproduce better than those printed on matte papers, and payment by newspapers is generally on publication; some of the smaller magazines follow the same practice, although the general magazine practice is to pay on acceptance. Each picture should be well captioned so that there is no mistake as to what the picture is about and each photograph should bear the photographer's name and address. Enclose return postage if you want the pictures back when rejected.

You can't make a lot of money this way, but you may be able to get enough to buy odds and ends of gadgets you want to buy now and then but which might not be within your reach otherwise.

New Reflex

A MIRROR reflex camera recently introduced by the Mimosa American Corporation is distinguished by the fact that its winding knob does four things at one turn of the knob; namely, winds the shutter, moves the film one frame, actuates the film counter, and sets the mirror for use. Film size is 2¼ by 2¼. It has a focal plane shutter with speeds varying from one second to 1/1000th and self-timer. Lenses are interchangeable up to 40 cm. focus, the purchaser having a choice of one of the following three standard lenses: 10 cm. Meyer Trioplan F:2.8; 10.5 cm. Zeiss Tessar F:3.5 and the 10.5 cm Meyer Makro-Plasmat F:2.7.

Filing Data

MANY times it must occur to you as you read photographic articles and manufacturers' literature that this and that piece of information might some day prove useful. If you let it go at that, simply relying on your memory, you will find yourself wishing now and then as you are working over some difficult problem that you had copied down a particular formula you had read somewhere because now that you need it you just cannot remember it.

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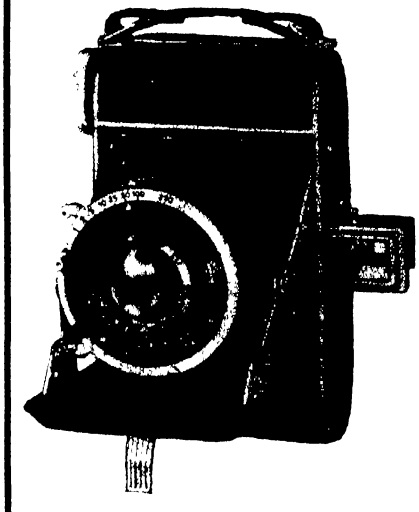

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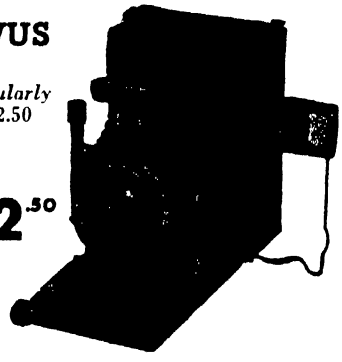

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clipping it or copying it in a notebook. But do not keep these jottings lying loosely about; file them away, preferably in some card index arrangement. Formulas and other helpful photographic data can be pasted on a card or written out on it. Have a convenient heading for each card so that the cards may be filed under general headings; as each classification grows, you should subdivide the headings to expedite finding the reference when you need it.

You cannot always clip or copy all that you want. In that case, whether it is a book or magazine, make out a card, with the proper heading, say "Portrait Lighting," and on it indicate title and substance of article, name of author, name and date of magazine, as well as page number on which the article appears. This indexing arrangement is advantageous whether the magazine is your own or was read at the public library.

"One-Camera" Magazines

THE vogue of the special monthly magazines devoted to a single camera or line of cameras, so well introduced in the interests of Leica and Zeiss, has been adopted by the Rolleiflex and Rolleicord distributors in a quarterly packed with valuable information for users of these cameras.

Itinerant Photography

THE recent publication of a booklet extolling the pleasures of itinerant photography recalls to this department a camera adventure on a bicycle trip in Bulgaria one autumn when a trio of shepherds, after being photographed, made it clear by various signs that they expected the photographer to pull a picture out of the black box immediately afterward. They seemed rather crestfallen when the photographer wheeled off soon afterward without producing the picture.

Whatever one may think of the money-making possibilities of this rôle of Yankee peddler turned photographer, those of a romantic turn of mind will see its attractions right off. Men have sold books "on the road" and have sung and fiddled their way through Europe all for the joy of the adventure involved. So whether you need the money or not—preferably if you do not—you might do worse than consider itinerant photography as one unusual way of spending your vacation this year.

Tongs

THE use of tongs in picking films and papers out of developer, rinser, and fixing bath is an excellent practice to adopt. There is no chance of getting the fingers stained and the necessity of frequent rinsing of the fingers is obviated. Tongs may be obtained in wood or bamboo and the cost is very little.

Beach and Water

THIS is the time of year when pictures at the beach and on the water will take a good part of your film budget. If you are not careful about selecting the most striking subject-matter, you will find yourself using up considerably more film than the results justify. Enthusiastic appreciation of a beach or river scene is apt to lead to indiscriminate guess shooting in the hope of obtaining one perfect picture out of the lot.

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Leica Manual, *by Willard D. Morgan and Henry M. Lester.* A beautiful book of over 500 pages dealing with all phases of miniature photography. It covers such subjects as panoramas, photomicrography, dental, stage, and aerial photography, photomurals, infra-red, and many others. $4.00.

Practical Amateur Photography, *by William S. Davis.* Deals with the whole subject from the origin and growth of photography to the latest types and uses of cameras. 264 pages, illustrated. $2.40.

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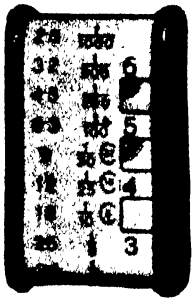

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But that isn't the way to do it. Shoot only when conditions are right, giving proportionately more time to study and observation of the scene than to the actual snapping of the shutter. Try for delicate rather than harsh contrasts and to this end avoid the middle part of the day when the sunlight is strongest. A beach or river scene, particularly at sunset, can be very beautiful, but thoughtlessness and carelessness will practically always give disappointing results.

Photographer Into Antiquarian

THE camera-hobbyist who likes antiques but either cannot afford to purchase them or prefers to photograph them both for their picturesqueness and historical value may fully justify this predilection in

". . . pictures of old things . . ."

a number of ways. There are the antique shops, with their window or sidewalk displays, for one thing. Sometimes the light strikes certain pieces in a particularly attractive way and then you have an opportunity to get a reproduction of the object that is at the same time a record and a pictorial achievement. Old houses, old streets, old signs, old statues can be had for the searching. In your walks about town you will stumble upon many odds and ends of architectural detail that will make interesting additions to your growing collection.

Collecting pictures of old things is the next best thing to collecting the old things themselves and you can in time accumulate a collection that will be worth while from the historical and the antiquarian points of view as well as the pictorial. If you go in for photographing old buildings and streets, there may come a time as the world moves forward when these will be eliminated to make way for new buildings and modern streets. Then the pictures you have made will have become valuable documents not only to yourself but as historical links in the town's growth, that will be perused with great interest by the town's historians and antiquarians in later years. In filing pictures of landmarks, it is well to put down all necessary data as to date picture was made and other particulars that might be helpful in studying the picture long after the landmarks have been torn down.

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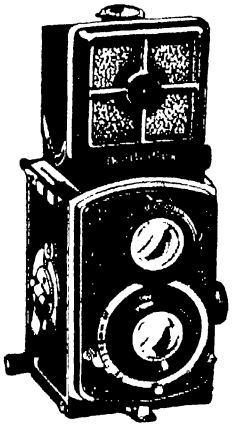

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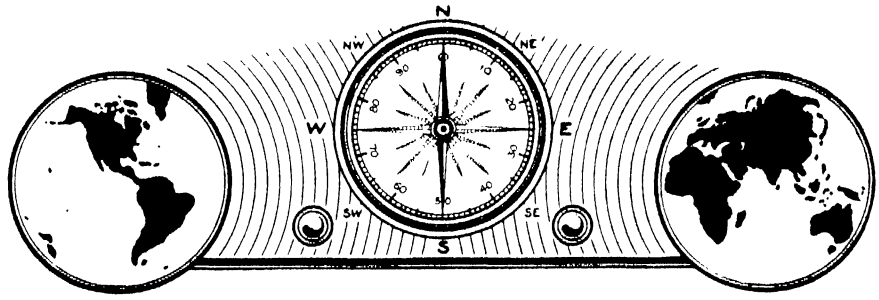


WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN
Editor, *All-Wave Radio*

"HINDENBURG" FREQUENCIES

OWNERS of all-wave receivers will have ample opportunity to receive 'phone transmissions from the dirigible *Hindenburg* during her scheduled transatlantic flights this summer.

The radio transmitter on the *Hindenburg* is equipped to operate on numerous frequencies but has been heard the majority of the time on the following frequencies: 5.8 mc, 10.2 mc, 12.9 mc and 14.4 mc.

Since the transmitter is continually changing in its distance from the points of reception during the flights of the *Hindenburg*, it is not practical to employ a fixed frequency for a certain time of the day, as done by land stations. The frequency used will depend upon the distance of the dirigible from these shores, the higher frequencies being used when the ship is the greatest distance away. Consequently, when she is some distance out, the transmitter is more apt to be heard in the vicinity of 12 or 14 mc, whereas when she nears our shores, the transmitter will more than likely operate in the vicinity of 5 or 10 mc.

The transmitted frequency is varied to take advantage of the "skip distance" of radio waves at various frequencies at different times of the day and night. This is the usual procedure in all short-wave radio communication.

ULTRA-SHORT WAVES

IT has been the general belief for some time that signals transmitted on wavelengths below 7 meters were limited to the optical horizon. Theoretically, such signals cannot be received beyond the line of sight, as they are not presumed to be "bounced back to earth" in the manner of the longer wavelengths. Such signals are supposed to pierce the ionosphere and continue out into space at a tangent with the surface of the earth.

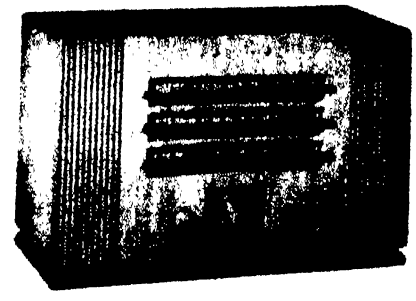
Yet such signals have been heard at distances that discredit this theory. Commercial U.S. transmissions in the vicinity of 7 and 8 meters, which are supposed to be confined to a very small area, are heard regularly in England. Radio amateurs have covered great distances with equipment operating on 5 meters. A west-coast amateur station is heard quite consistently on the east coast and in the south, and it has been reported that an amateur in upper New York State has carried on a two-way conversation with another amateur in England, both operating on a wavelength of 5 meters.

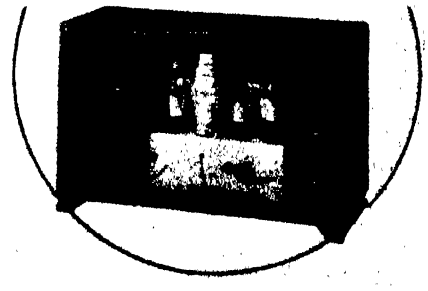
Such receptions have been a bit too consistent to be classed as freaks. Now Dr. Ross Hull, Associate Editor of *QST*, has presented an acceptable theory based on 15 months of research, that these ultra-short waves are affected by atmospheric conditions, such as the moisture content of the air, temperature gradient, and so on, much more so than the longer waves. Under the proper atmospheric conditions, these ultra-short waves are reflected back to earth just as the longer waves are, with the difference, presumably, that waves below 7 meters are bent back to earth right in our lower atmosphere, rather than from the ionosphere which is found some 60 miles above the surface of the earth.

Dr. Hull's theory is in accordance with recent researches carried on in England in conjunction with the transmission of micro-waves below 50 centimeters in length. It has been found that certain atmospheric conditions, such as moisture content of the air, have a definite effect on these tiny micro-rays.

BATTERY-OPERATED RECEIVERS

THERE is a general belief that the battery-operated receiver cannot compare with the a-c operated set. As a matter of fact, the operating efficiency of the modern battery set is by far the greater of the two.





"Kadette," an example of a battery-operated broadcast and short-wave portable superheterodyne receiver

There is little the a-c set can do that the battery set cannot also accomplish. Both have equal sensitivity and selectivity; both are equipped with automatic volume control; both have dynamic type loudspeakers; both have the same handling convenience. For that matter, they even look alike.

Netherlands' Station Active

THE Dutch short-wave station PCJ, at Eindhoven, Holland, operating on a frequency of 9.59 mc, is very active these days and is laying down a fine signal in the United States. The programs are of good

Edward Startz, the world famous announcer at station PCJ, Holland

quality and very little fading has been encountered on the signals.

Until recently, the PCJ programs directed to North America have been heard only on Sunday evenings, from 7 to 8 P.M., eastern standard time. North American programs are now heard Wednesday evenings as well, from 8 to 11 P.M., eastern standard time.

Mr. Edward Startz, the famous announcer at PCJ, makes announcements in Dutch, English, French, German and Spanish.

Amateur's Ace Band

THE recent floods focused the attention of the public on the radio amateur, with the result that many all-wave listeners have experienced for the first time the numerous thrills that crop up in this unique hobby.

The 20-meter amateur 'phone band, which extends from 14,150 kc to 14,250 kc, is of particular interest for two reasons: first, the band may be used only by holders of Class A licences—an advanced grade; second, it is a long-distance band and it is possible to pick up signals from foreign countries with the simplest of receivers.

Amateurs operating radiophone stations in the 20-meter band come from all walks of life. There are numerous dentists, doctors, and ministers, a banker, a well-known musician, a well-known publisher, a movie sound technician, a few cotton growers, and so on.

During the summer months, this band is particularly good from six in the evening until after midnight. During one evening, from 7 till 10, amateurs in the following countries were heard: Cuba, Bermuda, Canada, Nova Scotia, Barbados, Jamaica, Panama, Venezuela, Nicaragua, Brazil, Argentina, England, Belgium, Holland, Spain, Canary Islands, and Egypt!

If you enjoy DX, and you dislike waiting long to find out the location of the transmitter, by all means try the 20-meter band in the early evening. But tune above and below the limits of 14.15 to 14.25 mc, as the foreign amateurs operate outside the American 'phone band. You'll find them just above and below these frequencies.

Diversity Reception

IN an attempt to outwit the fading of signals transmitted at short wavelengths, radio amateurs have turned their efforts to the development of practical systems of diversity reception. This is an arrangement comprising two receivers and two aerial installations.

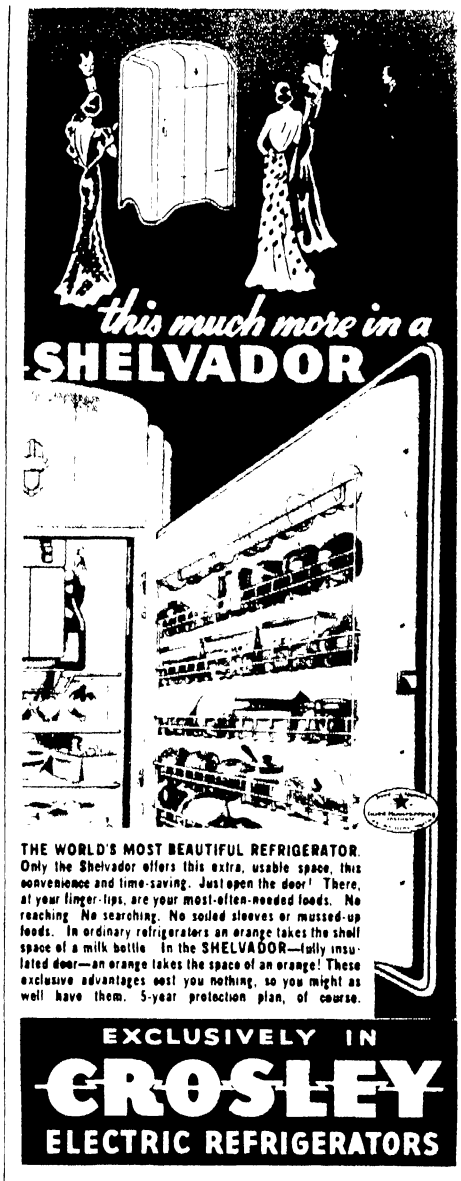
Diversity reception has been used commercially for many years. The commercial systems are highly complex and cannot be readily duplicated by the amateur or the all-wave listener, but there are simpler systems that will give an improvement over single-area reception.

Diversity reception is based on the fact that a radio signal does not go through an equal and simultaneous fade over a very wide area. On the contrary, the fade may be said to travel from one area to another with the result that during the period when the signal is of low level at one point, it is comparatively high at another point.

Therefore, if two antennas, well separated from each other, are used to feed separate receivers, the signal level will be up in one or the other of the two receivers in the majority of cases, with the result that at least one of the received signals will rarely fall below the noise level. By interconnecting the automatic volume control circuits of the two receivers, the stronger of the two portions of the identical signal being intercepted may be made to "kill off" reception in the receiver in which the signal level is low so that neither receiver can reproduce background noise. This balance between receivers is maintained at all times and the receiver to which the control is given is the one intercepting the higher signal level.

For best results the two antennas comprising the pick-up of a diversity system should be spaced more than 200 feet apart —the greater the spacing, the better the results. However, a fair system can be arranged by stringing the two antennas from the same pole, but running the wires in opposite directions. The automatic volume-control circuits of the receivers need not be interconnected, but the results will be more pleasing if they are. If the receivers are operated separately, with no interconnecting circuits, the receiver intercepting the signal of low level will run "wide open" and hence amplify local noise.

A more appropriate scheme for those who do not wish to go to the trouble and expense of installing a complete diversity reception system is the use of two well-separated antennas of the doublet type with their feeders connected to a double-pole double-throw switch which can be operated rapidly. With this arrangement, it is easy to switch from one to the other antenna when fading commences.



The Fundamentals of Radio

By R. R. Ramsey, Ph. D., Professor of Physics, Indiana University

The first edition of this valuable text book appeared in 1929. Now the second edition has been published, bringing the whole subject thoroughly up to date. The book was written as an elementary text for college students but it can be read with profit by anyone who has a fair background knowledge of electricity and elementary mathematics. True, the author introduces calculus in a few places but the reader who is not familiar with this phase of mathematics can pick and choose. The text is thorough-going, from an explanation of direct and alternating currents right straight through to the very latest types of multi-element vacuum tubes and television. This is not in any sense a "how to make it" book or a compilation of various "hook-ups." Rather it is a solid, meaty exposition of the principles underlying the many phases of radio. 426 pages, well illustrated, and printed on good paper. $3.50 postpaid.

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 39)

ject viewed through the resulting filter would appear bright with dark spots. A green object, on the other hand, would appear dark with bright spots. This is a type of discrimination which would be easy for the color-blind person."

Moth Trap

A NEW method of protecting clothing and other wool fabrics against the attack of moths depends on the use of a poisoned bait to attract the moths away from the wool to be saved and to kill the larvae before they can damage the material. A mass of wool is saturated with an arsenic compound and greased thoroughly to invite moths to lay their eggs. This poisoned bait is hung in the closet with clothing and is said to be so attractive to the insects that they will leave valuable woolens untouched. As soon as the eggs hatch, the larvae feeding on the poisoned wool are killed before they can do any damage. Such treated wool is marketed in convenient form under the trade name, Moth Wool.—*D. H. K.*

Orchids for Men

THE orchid, as a flower, is associated with wealth, lavish display, and a certain amount of culture. It has distinguished, though sometimes bizarre, appearance, gorgeous colorings, but most important, it is necessarily expensive, and is likely to remain so. It is a fit floral companion to the diamond, to ermine, and to the limousine. The orchid, as a cut-flower, is not to be raised in gardens, but is a hot-house product, to be cultivated only by specialists says the *Industrial Bulletin* of Arthur D. Little, Inc.

Orchids are of many types, ranging from the beautiful "lady's slippers" of our pine woods, which grow in the ground like other plants, to the most showy and flamboyant plants which grow epiphytically in the moist forests of the tropics, where they perch high in trees. These absorb their food mostly from the air by means of remarkable dangling roots. It is only selected, cultivated forms of the tropical orchids that are of interest commercially for their flowers.

Many years ago, the plants were brought bodily to the temperate zone, where they survived, with difficulty, for a year or two, in greenhouses. After many disappointments, it was found possible to raise orchid plants from seed, and, beginning in 1856, to breed them for "points." The technique of germination was not, however, really perfected until within the last 15 years. This means not only improvement of the scant, bedraggled, and insect-infested foliage of the wild plant, but improvement of the flower itself, especially as to coloring and time of blooming. Today, cross-breeding or hybridizing is done on a large scale, not only by rich men's gardeners, as in the earlier days, but also by large commercial interests. All of the finer hybrid types today possess authentic pedigrees.

Orchids range through all the colors of the spectrum, and through a great variety of shapes and odors. Though many orchids

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are odorless, those that are provided with scent may duplicate almost any other flower. On a fact-finding smelling tour through a large orchid house, odors of peony, rose, narcissus, and jasmine were found to be conspicuous, but somehow none with the so-called "orchid" odor of the perfumes could be located. Vanilla, the flavoring material, is obtained from the fermented and then dried pod (so-called "bean") of a vine-type orchid native to Central America, and is one of the few commercial products of this family of plants.

As a result of improved understanding of breeding and raising orchids, the plants may now be produced in great numbers, and in healthy condition, at a reasonable price. There is a move to promote orchid-growing as a hobby in this country, as it has been in England for nearly a generation. Single plants of many species, selected for suitability, and ready to bloom, may now be had for as low as five dollars to 20 dollars, with some of the commoner ones down to two dollars. These bloom once a year, the flowers usually last a month or more, and the plants even may be raised on a partly shaded window sill, if protected so that they do not get chilled below 40 or 45 degrees, Fahrenheit, at any time. They have not been developed yet so that they stand drafts well, or thrive in dry air, but they can be raised in homes even without conservatories.

A display of orchids may appeal more to men than to women. To many women, an orchid is a real decoration to wear, to be valued for the sentiment behind it, or for the distinction which it gives, but is not so truly likable a flower as some clean-cut compact flower such as a gardenia. To men, any sprawliness of the flower may be overlooked in view of its unique character, and its numberless variations of color and shape. It is perhaps more than a coincidence that recent articles on orchids are mostly in magazines read chiefly by men. Further, orchid raisers tell of men who have been seen to visit their exhibitions nonchalantly, while with ladies, only to come back alone, later, to revel in the details of the individual plants and in the strange exotic atmosphere.

LEFT-HANDEDNESS

LEFT-HANDEDNESS is half again more frequent among boys than it is among girls, in a group of 7651 school children observed by Dr. M. Schiller, city physician of Stuttgart, Germany.

VERSATILE SYNTHETIC RUBBER

THIOKOL, a synthetic rubber-like material made from dichloro-ethyl ether and sulfur, has been found to be 25 times more effective than rubber in holding helium in the bags of balloons and dirigibles, according to tests recently made. One of the important properties of this synthetic material is its ability to resist oil and gasoline, which has led to its adoption as standard material in all gasoline and oil hose used by the United States Army Air Corps. The gasoline tanks on the *China Clipper* and other giant flying boats in the transpacific airmail service are lined with Thiokol to prevent leakage and to seal any accidental punc-

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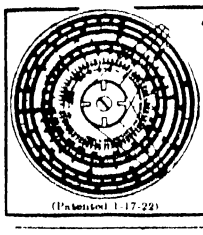
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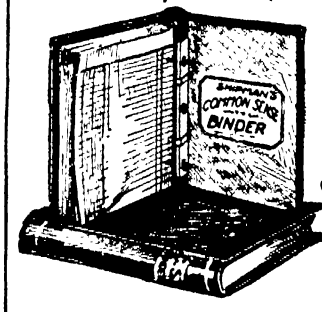

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SOIL WEALTH

IN certain types of soil, says Professor Rudolf Gistl, of the Munich Technical School, one-celled green plants of the class known as algae are the chief source of energy-food for the nitrogen-fixing bacteria that enable profitable crop plants to grow.

Poison Ivy

WITH the arrival of the picnic season, Dr. James F. Couch, of the Bureau of Animal Industry, United States Department of Agriculture, stated in a recent radio talk that the specific poison in poison ivy is a compound related to phenol (carbolic acid) known as toxicodenrol and that the method of protection and of treatment must be based on this fact. He suggests that a person sensitive to the poison should bathe his exposed skin with a 5 percent solution of ferric chloride in a mixture of equal parts of water and glycerol before going near the weed. This solution confers substantial protection against the poison. Another protective solution to be used similarly is a 5 percent solution of ferrous sulfate (copperas) in water. The materials may be obtained at any drug store.

After exposure, washing with an alkaline soap, particularly yellow laundry soap, neutralizes and dissolves the poison and if done soon enough after exposure is effective in preventing a rash. Various oxidizing agents also destroy the poison by converting it into a harmless resin, according to Dr. Couch, and of these the most effective is a 5 percent solution of potassium permanganate in water. Hydrogen peroxide has also been used but it is usually painful in its effects on the irritated skin. The brown stains made by permanganate can be easily removed from the skin by washing with weak oxalic acid solution (1 percent), or with solutions of photographers' hypo or sodium sulfite.—*D. H. K.*

Underneath Lathe Drive

A NEW nine-inch belt-driven lathe is mounted on either a frame or cabinet bench while the underneath motor drive unit and motor are supported on a pivoting frame under the bench top. The belt tension release crank handle controls the position of the frame and countershaft. When the tension release crank handle at the front of the cabinet is moved in a semi-circle, the entire driving unit is lifted vertically about 2¾ inches, so that the spindle belt may be shifted. Any adjustment in the tension of the spindle belt can be secured by a turnbuckle attached from the crank handle to an arm of the countershaft. A hinged cover encloses the headstock which can be raised upward when desiring to shift the cone pulley belt.

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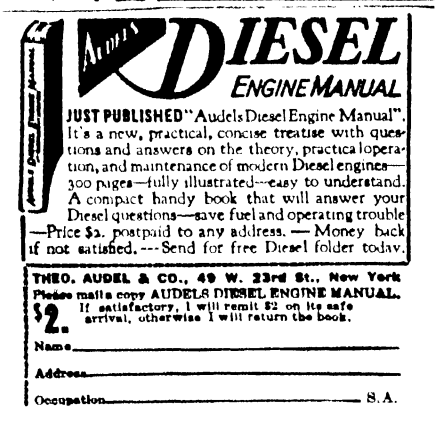

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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COVER

MODERN industrial plants furnish a rich source of dramatic material to the photographic illustrator. An outstanding example of this work, by Robert Dudley Smith, is reproduced on this month's cover. The scene is in the plant of the Alan Wood Iron and Steel Company. In the foreground is a ladle train which carries molten metal from the furnace to the molding machine from which the pigs are dropped directly into railroad cars for shipment. These "runs" of iron are made about every four hours in this plant.

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50 Years Ago in . . .

Scientific American

(Condensed From Issues of August, 1886)

PHOTO-ENGRAVING—What was apparently the first half-tone photo-engraving to appear in Scientific American depicted, on page 101, August 14, 1886, a log jam on the St. Croix River. The illustration (it cannot be reproduced here) forms a striking contrast to the wood engravings ordinarily used at that time. Thus was marked a significant transition period in the publishing world.—*The Editor.*

SUBMARINE "For some time past Lieutenant Zalinski has been experimenting with a novel submarine torpedo boat, the invention of Mr. John P. Holland. The boat can be sunk to any desired depth below the surface of the water, propelled in any direction, and brought to the surface at any time. The boat has a wooden hull, is cigar shaped, and measures 50 feet in length by 8 feet in diameter at the largest part. The floating surface, under ordinary conditions, is 30 feet long. . . . The propeller is driven by a petroleum engine. . . . When fitted for actual service, the bow of the vessel will be provided with one of Lieut. Zalinski's compressed air guns for throwing cartridges charged with nitro-glycerine."

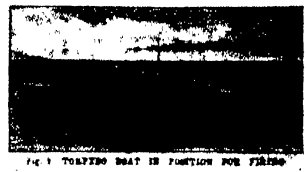

FIG. 1 TORPEDO BOAT IN POSITION FOR FIRING

CRUISERS—"It could scarcely have been expected that the [Naval] Board would originate a new system of marine architecture or otherwise revolutionize naval warfare. The most that could reasonably be hoped for was that it would intelligently examine the best models of the Old World naval constructors, who have had large and varied experience of recent years, while we have been standing still, and discover which were best suited to the purpose Congress had in view."

FIRE FIGHTING—"A novel system of fire extinguishing, just introduced in London, consists of a tricycle with which are embodied the following: 1. A hose reel carrying a large quantity of specially constructed hose for winding in a small compass. 2. A light double-pump fire engine, capable of throwing 25 gallons per minute, to be worked by two pumpers. 3. A simple fire escape, with descending ropes and bag. The machine is run at full bicycle speed by two men."

MILK—"Alarming results may be produced in both children and adults by the use of milk taken from improperly fed cattle. There have recently been a number of mysterious poisoning cases that after a great deal of random speculation have finally been traced to diseased milk. In spite, however, of these warnings, the subject has not yet received the sanitary attention to which it is entitled."

HOT WATER—"A remarkable example of the increase of temperature in the earth toward the center has been presented at Pesth, where the deepest artesian well in the world is that now being bored for the purpose of supplying the public baths and other establishments with hot water. A depth of 951 meters 3,120 feet—has already been reached, and it furnishes 800 cubic meters—176,000 gallons—daily, at a temperature of 70 degrees C.—158 degrees Fah."

LUMINOUS STONE—"Messrs. W. C. Horne and E. Ormerod, of London, England, have recently invented a method of utilizing the luminous powder prepared mainly as a sulphide of calcium, for admixture with cements, plaster of Paris, and concrete, the object being to prepare the articles with a self-contained phosphorescent property instead of coating them with luminous paint."

BALLOON VOYAGE—"M. M. L'Hoste and Joseph Mangot have lately made a balloon voyage from Cherbourg, in France, to Tottenham, a suburb of northern London, near Alexandra Palace. The main object was not so much an experiment, to prove the power and accuracy of steering, as to ascertain the possibility of maintaining an equable altitude above the waves in crossing the water. This was done by means of a pipe extending into the waves, and by means of which water could be drawn up to be used as ballast in counteracting the condensation by rarefaction of the gas which causes balloons to shoot upward."

EMERY—"The particles of material removed from solid bodies by the abrasive action of dry emery wheels are always more or less heated. Dust from metals is often fused, and sometimes dissipated altogether. Fused globules of metal are frequently found in emery wheel dust, but the stalagmitic formation consisting of particles welded together, as shown in our engraving, is not common."

PLANER—"When finished, a new [planing] machine will weigh 35 tons, and it is to be capable of planing the edge of a plate of 38 ft. in length by 5 ft. wide. It is specially intended to be employed in connection with the preparation of steel plates for the girders of a railway bridge which is about to be erected across a river in New South Wales."

OIL ON WATER—"Another instance of the marked benefits resulting from the use of oil on troubled seas was afforded by the recent experience of the steamship *Werra*, of the North German Lloyd's Line, which was disabled in mid-ocean during her last transatlantic voyage. The steamer had been taken in tow by the *Venetian* when a strong gale prevailed and heavy seas were constantly breaking over the bow of the *Werra*, endangering the tow lines, and threatening the loss of the tow. The captain of the *Venetian* caused an oil bag to be hung from each side of his vessel and dragged some distance astern. The result was almost immediate, and the sea became comparatively smooth around the disabled ship."

CREMATION—"Next month the Parisians will be able to burn their dead in four crematory furnaces, which have just been finished at Pere la Chaise."

AND NOW FOR THE FUTURE

- How Modern Aerial Photography Aids the Archeologist
- Frog Farming—Its Present and Future Possibilities
- Science and Paper, by Philip H. Smith
- The Black Widow Spider—Still Increasing
- Bridges as a Menace to Highway Safety
- Up To Date on Cosmic Rays—More New Knowledge

THIS is vacation time. Millions of people are away. Other millions are getting ready for trips—to mountains and seashore and lakes—to the country or to foreign lands.

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ON the south slope of Mount Hollywood, overlooking a panorama of the Los Angeles coastal plain, is the Griffith Observatory and Planetarium. The large south dome houses the planetarium, where the famous Zeiss instrument is daily put through its paces. The smaller domes contain respectively a 12-inch refracting telescope and a solar observatory. The entire institution is devoted to the ends of public education.

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Table and Illustrations courtesy Travelers Insurance Company

How hasty, needless, and careless actions of drivers piled up the accident record in 1935

ARE MODERN CARS SAFE?

The Driver is Usually to Blame . . . Engineering Developments Promote Safety and Comfort . . . How Streamlining Fits Into the Scheme of Things

By PROF. ALEXANDER KLEMIN
New York University

IT is fashionable in certain quarters to attack the modern streamlined car as unsafe. The most common criticism is that these efficient cars are too highly powered, and therefore tempt drivers to excessive speeds and to "squeezing" through traffic. Another criticism is that streamlining and lower passenger seating decreases visibility. It is also claimed that modern cars have poor roadability and that light coupés and runabouts attain speeds at which they "wander" on the road. High steering ratios are said to produce sluggish control. Low ground clearances are held to be a source of danger to the transmission and exhaust systems. Poor ventilation and exhaust gas fumes are stated to be the direct cause of frequent accidents. These are serious indictments and deserve calm, impartial consideration.

A careful statistical study made by the Travelers Insurance Company seems to refute these views, and to place greater blame on the driving public than on the design or condition of automobiles in service.

For the year 1935, there were 826,690 recorded automobile accidents in the United States. Only 5.7 percent of the fatal accidents were due to non-collision. The remaining 94.3 percent were divided among the following types of collisions: with pedestrians, 36 percent; automobiles, 45.3 percent; horse-drawn vehicles, 0.6 percent; trains, street cars, and other vehicles, 3.2 percent; bicycles, 2.4 percent; fixed objects, 6.5 percent; and miscellaneous, 0.3 percent.

These figures are quoted because of their general interest; it is more significant that 532,720 accidents—approximately two out of every three—last year involved mistakes by drivers! Exceeding speed limit accounted for 22.8 percent of accidents due to driving errors; did not have right-of-way stood for 25.5 percent. Other errors—on wrong side of road, cutting in, passing on wrong side of road, reckless driving, and so on—made up the remainder (see the table above). And, while total deaths last year exceeded fatalities of the year before by about 300, mistakes of drivers figured in nearly 1500 more deaths than in 1934. Drivers seemed in particular not to consider the possibility of children suddenly appearing on the roadways.

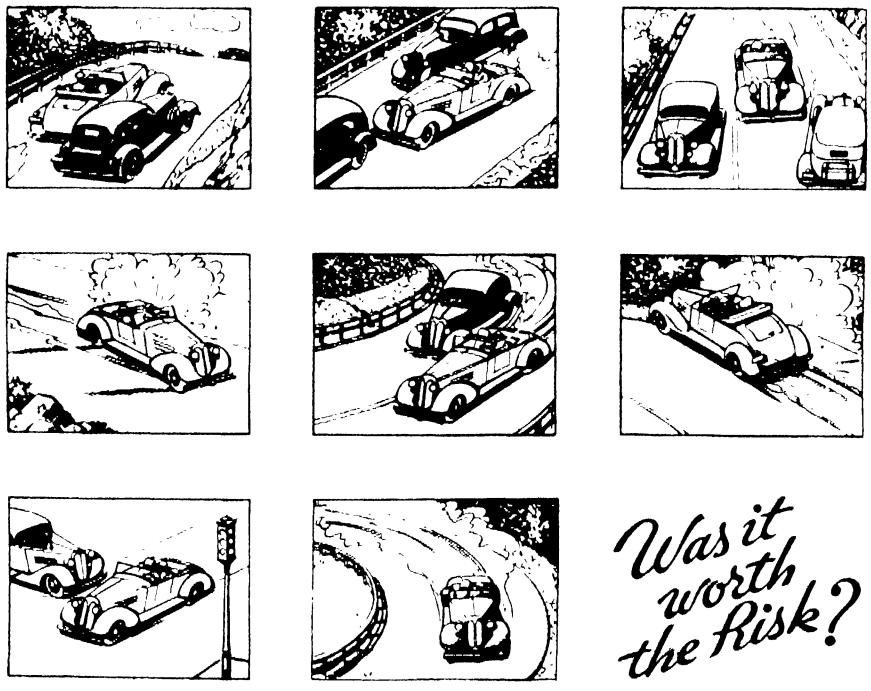
IN 95 percent of all accidents causing injury or death, cars were apparently in good condition.

If these statistics, compiled by so reliable an agency, are given credence, then the human rather than mechanical elements appear more to blame.

There is a curious, and perhaps unfortunate, pyschology which causes a driver to delight in the high speed, power, smoothness, and comfort of modern cars. The same man on foot will make little or no allowance for the high speed of an approaching car and will fail to observe elementary precautions. When pedestrians in cities cross against signals and in the middle of the block, they indulge in practices that are extraordinarily dangerous. As an example: the rate of death last year per pedestrian accident involving crossing against signals was 55 percent higher than when crossing with signals. Jay-walking is even worse. Last year's record also shows that the death rate where pedestrians crossed in the middle of the block was 200 percent higher than when crossing at intersections with the "Go" signal. Pedestrians who have to use the traveled portions of highways should also protect themselves as far as possible by walking against traffic rather than with traffic. The rate of death per pedestrian accident under such circumstances was 278 percent worse last year than the average of all pedestrian accidents.

It is on the score of high power and speed that critics of the modern car are most vehement. They have this fact to support their contentions: 30 percent of all fatal accidents in 1935 occurred when cars were driven too fast; the rate of death per accident which in-

..*and here are* some of the things he DID on the way up!



volved exceeding the speed limit was, for 1935, 35 percent greater than the average death rate for all accidents due to improper driving practices.

It is a matter of simple mechanics that the energy of impact, the distance required for stopping, and the centrifugal force on a turn are all multiplied four times when the speed is doubled. It is also perfectly true that drivers do not often use the maximum power and maximum speed that are made available to them.

Then why install high-powered engines in light cars? The answer is in three parts: (1) everyone likes to get going just as quickly as possible; (2) if the bare minimum of power just sufficient for good speed on a level road were provided, hills would become an intolerable nuisance; (3) engines or other machinery operating at the highest pressure will never work with the same perfection and reliability as when working well within maximum capacity. By building into the car the ability to operate at high speeds, engineers make it safer and more practical to run at reasonable speeds. Also, anyone who has driven a car for any length of time can recall emergencies successfully met by virtue of reserve power.

Another important fact to emphasize is that 77.2 percent of all accidents occur at low or moderate speeds. Governors to limit automobile speeds have frequently been suggested. The idea appears to be almost ridiculous. Will all cars in a given state or in all states have governors set at a given limit when some cars are perfectly safe at 80 miles an hour and other old-time designs are positively dangerous at 50? Will the same governor which provides reasonable limits for congested roads near a great city, such as New York or Chicago, be used on the long, clear, level roads of the West? Will anything please a mechanically minded public as much as a little tampering with the spring control of a governor? Will not the governor, by robbing the autoist of reserve power when this is vitally needed, actually reduce the safety on occasion?

A much more reasonable suggestion is to introduce a warning signal—a buzzer or a red light—to be actuated by the speedometer at a predetermined speed. This would have the advantage of warning a driver preoccupied by watching traffic or other tasks. A precedent exists for this less brutal precautionary measure in the red light which warns the airplane pilot that the landing wheels are not fully set down prior to a landing.

But, whether some such warning device is adopted or not, we believe that high speeds have come to stay, that to limit or reduce the speed of which a car is capable is a retrogression, and that education of the driver, stringent regulations, and penalties against dangerous speeds constitute the better approach to this problem.

THE critics seem to think that in the new modern streamlined cars, low seating, sloping windshields, and small windows have impaired the vision. To a certain extent this is true, and there is undoubtedly room for improvement. Automobile engineers might well follow airplane practice in this regard. In the design of the airplane adequate vision is secured no matter what structural difficulties or additional expenditures are involved; the windshield is made wide, high, and clear, with no corner posts to interfere with vision; the engine is brought down as low as possible in relation to the pilot; and windows are placed in the roof and in side doors.

In some respects, however, the streamlined car—the Airflow for example—embodies improvements in vision which were not available in its predecessors. The long, high engine hood has disappeared and in its place we find a smaller, lower and more rounded nose. The driver's seat has been moved closer to the windshield. Both changes have improved vision. Highly polished surfaces which reflect light used to bother the driver by their glare; in the new cars many such light reflecting surfaces have disappeared, others have been dulled.

Another phase of the recent attacks is related to sluggish steering. Power in steering has been sacrificed to extreme ease of operation, and with the present steering ratios, it is impossible, so the critics say, to correct a quick side slip, or to "feel" the vehicle, or to control properly in deep sand, snow, or mud. Now this question of steering ratios is thoroughly understood by engineers, and they could just as readily build in a more powerful but more fatiguing system. Ease of steering is in itself a measure of safety, since it les-

sens fatigue on long journeys and thus permits the driver to act more quickly in emergencies. We are convinced that automobile engineers have reached just the right compromise between power of operation and ease of operation.

Perhaps it will not be out of place to emphasize here some of the other excellencies of the modern steering gear. In many of the designs, for example, the gear is in front of the axle, and axle movement does not in any way affect the "geometry" of the steering mechanism. Thereby it is possible to give the wheel the comfortable rakish angle which drivers appreciate so much. The steering wheel then falls into a position which allows a perfectly normal grasp, and permits it to be turned with a simple fore-arm movement instead of the shoulder action which was formerly unavoidable. Modern design has also eliminated the transmission of road shocks to the steering wheel; the driver no longer has to brace himself against tearing of the wheel from his grasp. If the steering mechanism is dispassionately considered as a whole, it will be adjudged one of the finest achievements of the engineer.

IN a recent engineering paper we read the extraordinary statement that, with the vehicle weight forward as in modern cars, high-speed braking is only 60 percent as effective as on cars having the power plants placed behind the front axle. An intelligent schoolboy would refute this statement by pointing out that, with four-wheel brakes, the braking effort is substantially independent of the weight distribution, since the effort is applied to all wheels simultaneously. As a General Motors pamphlet points out, modern brakes are very powerful—a 100-horsepower car has 500-horsepower brakes, if compared with earlier practice. Moreover, the introduction of four-wheel brakes not only doubled the applied ground friction but has also reduced skidding tendencies. The hydraulic brake now gives perfect equalization of pressure, reduces loss of power to a minimum, and reduces possibility of misadjustment. Of course, the public may be at times careless of brake maintenance, or brutal in their application, but the engineers may well congratulate themselves on the modern automobile brake.

The next phase of the attack on the modern car deals with roadability. It is asserted that power and speed have been developed far in excess of road-holding power, that cross-winds and bumps are likely to throw the fast car completely out of control, that weight distribution adopted for easy riding makes road-holding faulty; that comfort has been gained at the expense of stability and control.

Considering first the effects of cross-winds, it should be pointed out in fairness to the streamlined car that cross-winds or quartering winds actually have less effect on a streamlined car, relative speeds and quartering angles being equal, than on an unstreamlined machine. It is perfectly true that at very high speeds, wind effects are likely to become more important than at low speeds, but streamlining and the lowered position of the center of gravity are precisely the required correctives.

Rather than abandon the advantages of streamlining, in a "defeatist" attitude, engineers should intensify their aerodynamic researches and seek greater stability against cross-winds by even more advanced external forms. Sir Malcolm Campbell and the airplane designers point the way to what can be done in securing great stability at high speeds by placing more lateral area behind the center of gravity.

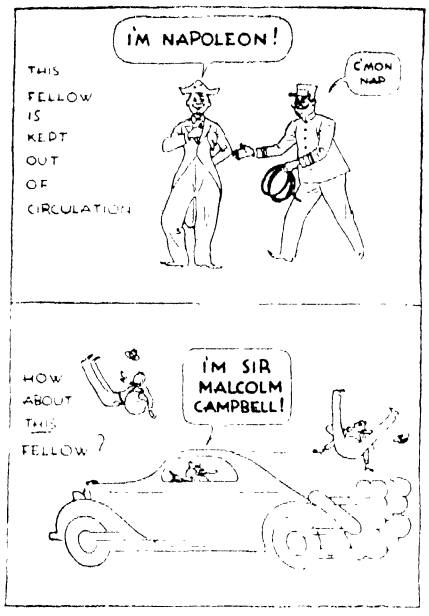
WHEN Chrysler engineers introduced streamlining to the American public, they coupled their advance with re-location of the passengers and engine, and lowering the center of gravity. There followed, besides a great increase in passenger comfort, many indirect advantages from a safety point of view. Common sense indicates that the lower the center of gravity the greater the restoring moment to act against turning over. It is almost unbelievable that technicians should have overlooked this important and desirable safety feature for so long. A low center of gravity also decreases swaying and increases stability on the road. The re-location of the weights so that they are distributed farther away from the center of gravity increases what the engineers term "the moment of inertia" and thereby again increases the stability.

Space will not permit us to deal fully with the dynamics and stability of the modern automobile. Strange as it may seem, it is only recently that there has come an understanding of automobile dynamics, although airplane dynamics have been intensively studied for 20 years.

It is extraordinary that, just as the moment when automobile engineers are giving such intensive study to dynamics, and to better equalized spring suspension, to decreasing the unsprung weight, to knee-action wheels, to "Floating Power," to rubber as a means of lessening vibrations, and so on, the critics should launch their attack on roadability and stability.

What do they want the car builders to do—abandon all their efforts for higher efficiency and power, admit defeat, and go back to the era of the Model T? Do these critics imply that the only roads we shall ever drive on will be full of bumps and ruts? Do they imply that the driving public is completely bereft of common sense and insists on driving at 70 miles an hour over the roughest roads and in strong winds coupled with driving rain?

Perhaps the only point that we are willing to concede is that, by placing



more weight on the front wheels, something has been sacrificed in tractive power under difficult road conditions—but such difficult conditions may be considered quite exceptional.

It is also asserted, as mentioned before, that, because of low ground clearance, exhaust systems, steering mechanisms and other parts in a like position are subject to damage because of obstacles, ruts, and bumps in the road. The answer here is that a low center of gravity is such a great advantage from a safety point of view, that to raise it would be a decided retrogression, and that on good roads such low clearance difficulties do not occur. With the enormous taxes paid by the motorist, he surely has a right to expect good roads!

TO attack the builders of automobiles in the public press makes good "copy," and to attack them in engineering and safety societies meetings creates a mild sensation and subsequent notices in the newspapers. Another curious fact is that criticisms of the automobile from a safety point of view generally come from engineers who are concerned with the teaching of automotive engineering or the testing of automotive equipment. It is easier to criticise a play than to write one, and, we may say with a little malice, that these highly informed and well meaning authorities on the side lines might take an entirely different point of view were they required to design and build cars to please and accommodate the public, and to meet severe competition. They would then, perhaps, recognize the necessity of certain compromises. Perhaps they would not overlook, also, what automobile engineers have already done for safety.

For example, in the last two or three years, we have seen the introduction of the all-steel body in which chassis frame and body are really integral with one another in a combined girder of immense strength. This type of construction eliminates squeaks, removes the danger of wood splinters in a crash, and provides a rugged strength which would have been deemed unattainable a few years ago. The recent installation of safety glass as standard equipment by the Ford Motor Company is an advance in safety which is highly and rightly appreciated by the public.

CREDIT for automatic engine control devices may be attributed to the automobile industry as a whole. These automatic devices act as guardians of the engine's life and give that extra power and acceleration which are so greatly needed at times. Engines fail and cars stall very rarely today. Such reliability is taken for granted, but it certainly is an element of safety. Tires to-day are expected to last as long as 10,000 miles without a puncture; another interesting item in the Travelers Insurance Company's pamphlet is that only 0.6 percent of all motor car accidents in 1935 were due to tire failures.

Safety campaigns, more polite but more determined police officers, strict enforcement of regulations, and public backing for the work of the authorities will do wonders for safety. Milwaukee gave last year a splendid example of what could be done along these lines. Evanston, Illinois, where a real effort by the authorities was backed by civic resolve, scored the safety record for all American cities of more than 50,000 population. It has been estimated that the Evanston methods universally applied would save the country approximately 25,000 lives annually.

There is but one reservation to be made in advocating rigid law enforcement. Let rules and regulations be severe, but also reasonable. For example: the Uniform Vehicle Code prepared by the National Conference on Street and Highway Safety provides for a speed which is reasonable and prudent—which is as it should be—but then promptly recommends an absolute limit of 45 miles per hour. Surely this limit is a retrogression and one which would be exceeded—and quite reasonably so—under certain conditions of clear sky, open level road, and little traffic.

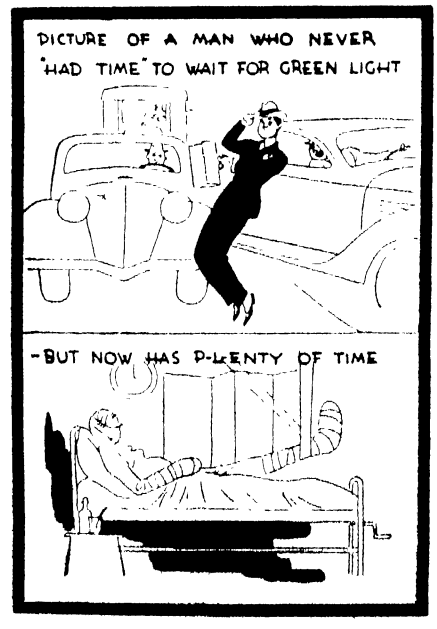
Mental and physical tests for drivers should certainly be stiffened. Safety education for children has shown remarkable results in decreasing accidents and fatalities. Adult pedestrians, jay-walkers, and stubborn optimists can profit equally by educational campaigns. More careful inspection of cars, as practiced in Pennsylvania, for example, is thoroughly worth while.

The principles of highway engineering are now clearly understood and have been successfully applied in many instances. We know perfectly well that, with a road of a certain curvature, the centrifugal force and the overturning moments due to centrifugal force increase with the square of the speed, but there are few attempts to bank the road on a turn proportionately.

Two lane highways in congested areas are definitely dangerous, and three lane highways are in some respects even worse because they actually tempt the motorist to hazardous passing. Head-on collisions can be effectively prevented by narrow parkways or walls that separate traffic moving in opposite directions. Collisions with parked cars may be avoided by marginal guards at the outer edge of the road, with parking prohibited within the guards. Intersection collisions can be prevented by the traffic circle, or by grade separation in clover-leaf crossings.

These principles are elementary; what is lacking is their more general application.

SUMMING up all the arguments, it must be admitted that higher automobile power and speed inevitably entail certain hazards. But to abandon such power and speed would be a step backwards, which the American public will not tolerate. Automobile safety is a complex matter involving education of the driver and pedestrian, stricter law enforcement, better highway engineering, and safety design of the vehicle. To lay all, or even a great part of the blame on the modern streamlined car is but a fad analogous to the writing of "debunking" biographies of great men. Of course, the modern car is susceptible of improvement from a safety point of view, and serious suggestions for "safety improvement" should be considered at all times. But our engineers and manufacturers are all doing everything humanly possible along these lines, expending money, time, and engineering skill without stint for increased safety.



OUR POINT OF VIEW

Science in Advertising

ONE doesn't ordinarily expect to find the subject of advertising discussed in an editorial in a scientific journal. Yet there is provocation and reason for an exception. Long have our thoughts on the subject rankled because science *is* concerned; and we have figuratively torn our hair and stifled public utterance. We refuse to continue this tacit admission that science has nothing to do with advertising. It has—or should have.

Having published some time ago an article on a widely used product, we were surprised when an advertising man telephoned to ask where he could get more such facts. He explained that they would provide new "copy" angles and said he was unaware that so much was known concerning the product he was handling. He was dumfounded when we told him there were volumes of material on the subject in the public library across the street. To us, this was the rankest form of something—heresy or *laissez faire* or ignorance or just plain laziness. Whatever it was, it stirred us as nothing has since the passing of Barnum. Any product on the market today, if it be "worth the powder," will have a history of research upon which the finest kind of selling copy can be written—copy that often is irrefutable.

The civilized world is science-minded. People see on every hand and use almost every minute of the day something that is better made, something that is magical because of science. Accepting these things as necessities, and reading about the science behind them in scientific journals or even the daily papers, as well as of new achievements of science, the public has become more concerned with the technical excellence of a product than with the glittering generalities in a bought and paid for statement from someone who does not even use the product.

We believe advertisers know this. It can't be that they've been asleep these past 50 fruitful years, these years that science has used to such advantage, these years in which the scientific press has done so much to educate people and point to future progress. Yet many advertisers (who should know better and certainly have a wealth of scientific facts on which to draw) go blithely on yodeling nonsensical ballyhoo.

To be specific, to show what can be done, let's look at some exceptions. The General Electric advertisement in our July issue, headed "How You Profit From This Discovery," is perfect scientific copy to sell electric-furnace brazing and, incidentally, an enormous research institution. Another example is an advertisement of the General Motors Corporation signed by President Alfred P. Sloan, Jr., which appeared recently in newspapers. Headed by an emblem bearing the splendid slogan "Who Serves Progress Serves America" and by huge display letters: "Millions of Jobs in the Rebuilding of the Nation," this copy told of the part Winton Diesels have played in the rebuilding of railroads on a streamlined basis. "They . . . vividly demonstrate that *opportunity has no ceiling in America.*" There are others—most of those in this journal, of course—but there are too few in the general magazines.

We congratulate most heartily those who have the understanding and foresight to take this long step forward, as the two mentioned above have done. May they have many emulators.

Sc. D.

WE scientific scribes write so continually of the achievements of others that it comes as a distinct and happy surprise when our own efforts in disseminating scientific knowledge are honored. Such was the case recently when Oglethorpe University, through its President, Dr. Thornwell Jacobs, bestowed an honorary degree of Doctor of Science upon our editor, Orson Desaix Munn ". . . . in recognition of your many great services to, and your high achievements in, scientific research."

Mr. Munn declares that the recognition comes, not to an individual but to an "institution of learning"—to Scientific American which, now in its third generation in one family, has interpreted and inspired scientific research.

The editorial staff, therefore, take this opportunity to express to Dr. Jacobs our gratitude for this signal honor he has accorded our associate and friend whom we heartily congratulate.

Movies Catch Criminals

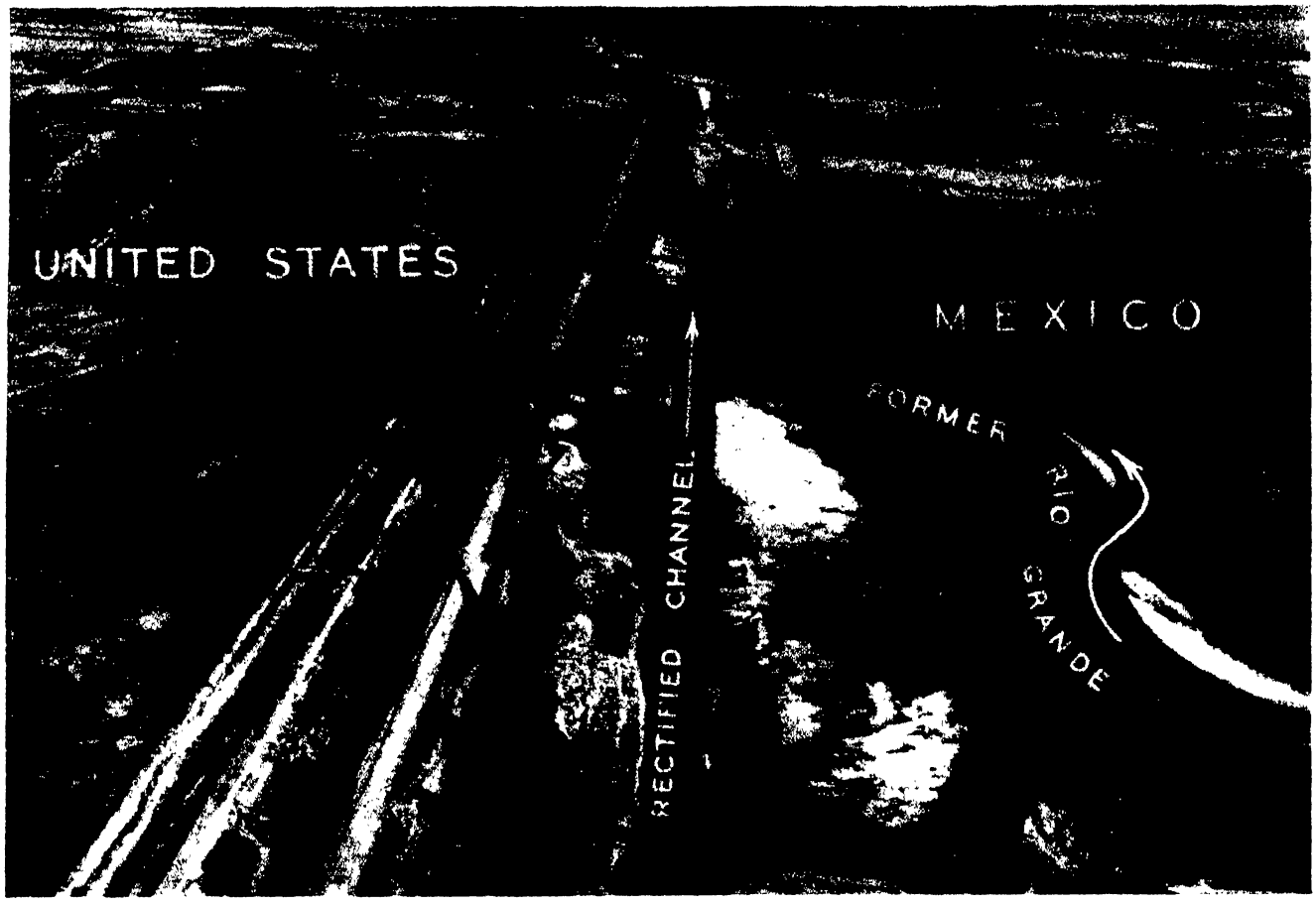
WHEN a crime has been committed, detectives know what to do in studying every scrap of evidence to determine, if possible, the identity of the criminal. When fingerprints are found at the scene, these often point to the guilty one; if he is a known offender, his record and photographs may be broadcast to peace officers everywhere.

An habitual criminal is keenly alive to the odds against his capture. He knows all the tricks of eluding arrest. Sometimes he "holes up" until the "heat" is off. Sometimes he tries simple disguises or he might even have his face altered by plastic surgery—though this is a far from effective disguise. Some wise ones, not too well known by sight to policemen and detectives, lose themselves in crowds in the Loop, on Tremont Street, or Broadway. Bertillon measurements and fingerprint records then mean nothing—until he is caught. He may even walk into a theater and sit next to you or me for all he cares about those records; Dillinger did and would have been "in the clear" had he not been "crossed" by a woman.

It seems a bit strange, therefore, that the aid of the public has never been seriously enlisted in the job of apprehending felons. Police forces are relatively small; the public is 125 millions strong. And the public loves movies.

Colonel H. Norman Schwarzkopf, until recently Superintendent of the New Jersey State Police, has drawn upon the facts in the preceding paragraph and worked out a solution. At Trenton recently he demonstrated a scientific method of making every movie-goer a potential crook-catcher. He would take movies of known criminals, walking, sitting, standing, talking, gesturing, smoking, and show these in theaters everywhere.

Genius—nothing less—adequately describes this development, for with it, not merely a picture but a living, breathing personality confronts the observer. A patron of a movie house, whether he is a tired business man in the city or a farmer attending a Saturday night show in a nearby village, will know the face, the gestures, the peculiarities of the crook's walk and talk. If he sees that combination of characteristics later, he is expected to call peace officers to make the arrest. But the system has other possibilities. Local police forces, even town constables, when asked to be on the lookout for some notorious bad man, will have, instead of a lifeless "front and profile," the same living person the public sees in the theaters. It is, therefore, like giving that one glance at the crook himself which is worth 20 rogue's gallery pictures.



Partially constructed works in the vicinity of Ysleta, Texas, of the rectified Rio Grande channel

STABILIZING THE RIO GRANDE

Meandering International Border Is Being Straightened . . . Canals, Levees Involved . . . Two Countries Exchange Territory . . . Prevent Future Damage

By L. M. LAWSON
American Commissioner, International Boundary Commission, United States and Mexico

MEXICO and the United States are trading territory. Three thousand four hundred sixty acres of Mexican land are being made a part of the United States and an equal American area is being transferred to Mexico. This is, however, no simple "horse trading" but an incidental result of the straightening and canalization of that section of the Rio Grande between El Paso and the Box Canyon below Fort Quitman, Texas. The rectification of the river at this point is one of the principal projects of international engineering now being administered and constructed by the International Boundary Commission, United States and Mexico.

The project plans and actual construction work represent the culmination of joint diplomatic and engineering negotiations between the United States and Mexico under authority and provisions concurred in by the two countries in the form of an international treaty on February 1, 1933, covering the stabilization of the boundary line and the rectification of the Rio Grande. This treaty also includes the construction of a flood retention dam and changes in present irrigation and drainage works ". . . to relieve the towns and agricultural lands located within the El Paso-Juarez Valley from flood dangers." Its aim is to secure ". . . the stabilization of the international boundary line, which, owing to the present meandering nature of the river, it has not been possible to hold within the mean line of its channel."

Previously existing treaties established the center of the Rio Grande, except in isolated cases, as the international boundary line. The channel, with excessive length, was produced by natural conditions which no longer exist. At the present time the bed of the Rio Grande between the two cities of El Paso and Juarez is at a higher elevation than some of the streets and improved properties of the two cities. Accumulations of sediment continue to aggravate this condition and it is the consensus of all engineers who have studied the situation that the correction lies in the plan of straightening and confining the channel. One of the principal requirements to permit of such artificial rectification is the equitable adjustment of the areas which would necessarily be detached from one side of the river and attached to the other in the straightening process.

The treaty of 1933 states: "Each Government shall respectively secure title,

control, and jurisdiction of its half of the flood channel, from the axis of that channel to the outer edge of the acquired right of way on its own side. . . ."

The location of the proposed channel has been so chosen and located in the field as to equalize the areas which will necessarily be segregated from one nation with those that will be cut from the other, with the result that neither nation will gain or lose national area. The acquisition of the private rights existing on such areas provides a feasible means for their exchange. The total cost of the project is estimated at 6,106,500 dollars and its construction will be completed in a year and a half from the present date.

THE general engineering features of this project involve: the reduction of river length from 155 miles to 88 miles; the establishment of a floodway between levees, with a capacity of 11,000 second-feet; and the increasing of the gradient from a slope of 1.82 feet per mile to a slope of 3.2 feet per mile. The levees require the placement of about 9,000,000 cubic yards of earth, their average height being 7.5 feet. Approximately 5,000,000 cubic yards of earth excavation is required to provide the artificial channel.

The areas required for right of way for the channel itself are 4075 acres from the United States and an equal acreage from Mexico, while the proposed location of the rectified channel segregates 3460 acres from the United States and an equal acreage from Mexico. In straightening the channel of the river, 59 separate tracts of land with areas varying from .25 acre to 377 acres will be cut from Mexico and 65 tracts will be cut from the United States. The treaty further states: "For the sole purpose of equalizing areas, the axis of the rectified channel shall be the international boundary line. The parcels of land that . . . shall remain on the American side of the axis of the rectified channel shall be the territory and property of the United States of America, and the territory and property of the United Mexican States those on the opposite side, each Government mutually surrendering in favor of the other the acquired rights over such parcels."

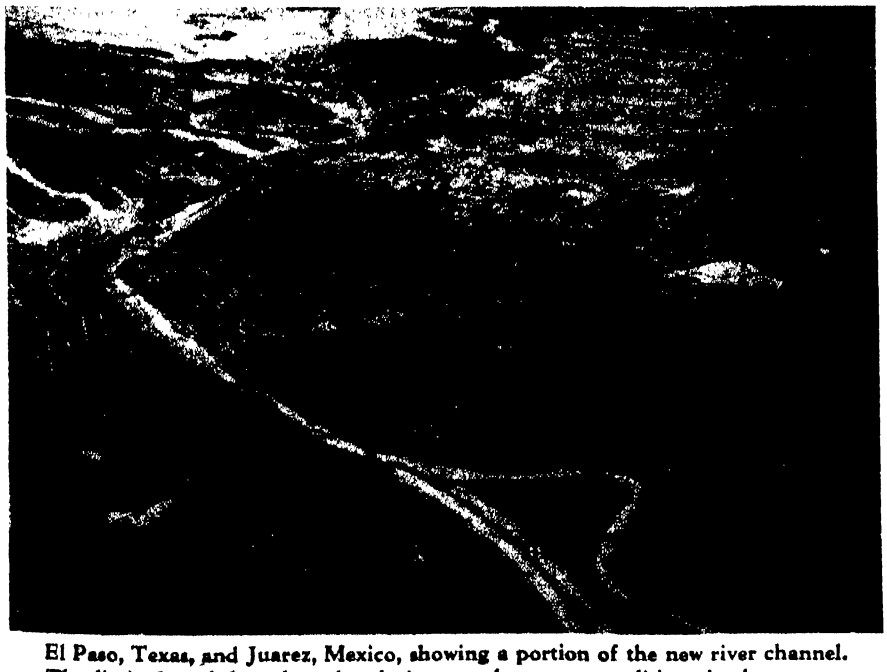
The results of the completed project will be the elimination of the flood menace throughout the El Paso-Juarez Valley in both the United States and Mexico; the prevention of channel changes and flood-caused detachment of areas from one country to the other; the reclamation of low-lying areas; and a more satisfactory enforcement of the immigration and customs laws of both countries.

The gross area of valley land in both countries, between El Paso-Juarez and Fort Quitman is 165,000 acres, of which 96,000 acres are in the United States and 69,000 acres in Mexico. Estimated values existing in the cities of El Paso and Juarez and their valleys, including irrigation and drainage works and improved roads, are in excess of 100,000,000 dollars.

Notwithstanding the fact that the present total amount of sediment annually carried through this valley by the Rio Grande is only a small percentage of that carried previous to the construction of the Elephant Butte Dam, the absence of the former large scouring floods has resulted in the silting up of the river channel to a point where rainfall-discharges from arroyos, entering the river between Elephant Butte and El Paso-Juarez, menace the improved and developed properties of both cities and the valley lands. Only large floods of destructive proportions are capable of eroding accumulations of sediment such as now occur in the meandering channel.

The city and county of El Paso and the Mexican Department of Communications and Public Works have expended in the last few years over 750,000 dollars to protect the cities and valley lands from floods. These works consist largely of levees built along the banks of the meandering channel, and require constant strengthening and repair because of the raising of the river bed.

The Rio Grande is a sediment-bearing stream, and as such is constantly building up its bed, and would from this cause, in time of flood, change its channel to a lower location where it would again start building up its bed and repeat the cycle at some future stage. The river has occupied at some time in the past every portion of the valley area. This phase of changing channel is now largely prevented through the El Paso-Juarez Valley by the construction of artificial works, such as railroad and road grades, canal and drain banks, and, in late years, levees. Under these conditions, the river bed has been continuously elevated. The Elephant Butte Dam was completed in the year 1916, and as a result of its function of providing an irrigation supply during years of low runoff, it stores the large floods which, previous to its construction, passed on down the river. The action of these floods was to scour the river channel, partly by carrying deposits on through the valleys and partly by making deposits upon the valley floor whenever bank overflow stage was reached. Although large floods have been controlled behind Elephant Butte Dam, smaller ones from the runoff area lying between Elephant Butte and El Paso-Juarez are of annual occurrence.



El Paso, Texas, and Juarez, Mexico, showing a portion of the new river channel. The limited work here has already improved seepage conditions in these towns

WITH the first release of clear water from Elephant Butte, a limited scouring of the river channel began immediately below the dam. The clear water picked up the finer particles of silt and sand and carried them downstream. This effect has reached some 40 miles below Elephant Butte, and might eventually reach El Paso and degrade the river through the valley, were it not for the annual increment of sand, gravel, and silt brought into the river channel from the many side arroyos which debouch into the stream along its course between the dam and El Paso. Even this annual increment of sand might be carried through were it not for the need of diverting the flow onto lands for irrigation. Three diversions are made above El Paso, one each at the Percha, the Leasburg, and the Mesilla Dams.

The Caballo Dam, a feature of the Rectification Project, will be located in

One of the principal canal intakes from the new channel for irrigation in the El Paso Valley

Sierra County, New Mexico, on the Rio Grande about 22 miles below Elephant Butte Dam. Studies of the Caballo Dam and the resulting reservoir have been made. The cost of this dam, including the purchase of the lands to be submerged, has been estimated to be 1,250,000 dollars for a capacity of 100,000 acre-feet.

The volume of water passing the proposed Caballo damsite during the large flood of September, 1925, was approximately 25,000 acre feet. Storage in excess of this amount must be provided to take care of possible larger floods and silt depletion. Provision must be made to store the probable spill from Elephant Butte during times of flood runoff below the dam. Fifty thousand acre-feet are allowed for this item and would probably store three or four days' spill. This would permit the floods entering below Caballo to recede.

In actual construction, levee heights will vary from zero, where bench lands are encountered, to 15 feet where the old river channel is crossed. The levee section proposed has a 16.4-foot crown with side slopes of two to one. This will permit of the use of the levee top as a road for inspection and repair. The normal flow channel is designed with a bottom width of 66 feet as this channel width seems best fitted for the present channel width of the river. The estimated capacity below the two-foot freeboard varies from 10,700 second feet to 11,500 second feet.

The total right of way is 8160 acres. This is equally divided between the two countries. In addition to the land actually occupied by the works, a strip 49 feet wide outside the land toe of each levee has been included for levee maintenance or possible future widening.

ALL earthwork of both channel excavation and levee embankment is being secured from the channel excavation in building the left levee from the lower end of San Elizario Island to the mouth of Quitman Canyon. At practically all the other locations the material is being secured from discontinuous borrow pits located on the channel side of the levees.

The sum of 225,000 dollars is carried in the estimate to cover the cost of rebuilding all constructed irrigation and drainage works where they will include the rearrangement of the irrigation systems on both sides of the river. Present bridges will either have to be lengthened or moved, depending upon how they fit with the new plan; probably several more will have to be built. The estimate of the amount of this item is 300,000 dollars. Because the effects of the introduction of steeper gradients in the river channel are problematical, and considerable scour may therefore develop, and because the irrigation supply must be diverted at certain places, there has been set up in the estimate an amount to meet the cost of grade control.

An allotment of 2,800,000 dollars was made January 3, 1934, by the Federal Emergency Administration of Public Works for commencement of Rio Grande rectification and construction works and also for the necessary acquisition of property. The American Commissioner received authority from the Secretary of State to begin construction on February 3, 1934. The Mexican Department of Communications and Public Works is carrying out the work on the Mexican side under the supervision of the Mexican Section of the Commission.

To date approximately 50 percent of the actual river rectification work has been accomplished, using long boom dragline excavators which have handled over 6,000,000 cubic yards of material. By transfer of funds to the Bureau of Reclamation, Department of the Interior, and the addition by that department of 1,000,000 dollars, storage capacity of 250,000 acre feet has been added to the proposed Caballo Reservoir, which will make possible the development of firm power from water released through penstocks at the Elephant Butte Dam.

A Weapon For Inventors

Who Was First? . . . Inventors Rights Must be Backed by Legal Evidence . . . How to Obtain It

By ORSON D. MUNN
Editor and Publisher

IT is a general principle of American patent law that the first inventor of any given invention is entitled to receive a patent for his invention. On its face this principle of law would appear to be simple enough. However, in applying and interpreting this principle considerable difficulty frequently arises.

Where two or more inventors are seeking patent protection for the same invention, each claiming to be the first inventor, the question naturally arises: At what point in the development of an invention does a person become the "first inventor" so as to be entitled to receive a patent as against all subsequent inventors? Is it when he first forms the mental concept or idea of the invention or is it when he first discloses it to others or makes a written description and drawings of his invention? Or, again, is it when he first reduces the invention to practice, making an actual working model which he successfully operates? Or, finally, is it at the time that he files his application for patent?

There is no definite and unequivocal answer to the above questions; the factor that determines which one of two or more claimants is the first inventor varies in accordance with the particular facts and circumstances. Suffice it to say for our purposes that all of the facts inquired about in the above questions are important in determining when an invention has been completed. In every dispute between two or more claimants for the same invention every fact in the development of the invention must be taken into consideration in deciding which of the claimants is the first inventor and entitled to receive a patent.

Where two or more parties have filed patent applications for the same subject matter, needless to say the Commissioner of Patents does not permit each party to decide for himself whether or not he is the first inventor. The facts as to who is the first inventor must be proved to the Patent Office by competent legal evidence. Accordingly, the principle set forth above that the first inventor of any given invention is entitled to receive a patent must be modified to read that the party *who can prove by competent legal evidence* that he is the first inventor is entitled to receive a patent. It is apparent, therefore, that the entire history of the development of an invention should be preserved in such form that it can be proved at a later date, if necessary.

In preserving the record of the development of an invention two guiding principles must be borne in mind. The first is that, after a lapse of time, human memory as to specific facts such as dates is highly unreliable and accordingly a contemporaneous record must be made as to these facts so as subsequently to refresh the recollection. The second is that the inventor himself is an interested party and his testimony should be corroborated by competent outside evidence, preferably both documentary evidence and the testimony of disinterested witnesses.

MANY different systems may be adopted to preserve the history of an invention. We outline here a plan which in various forms has proved entirely satisfactory. It applies both to the individual inventor who invents on his own behalf and to an employee whose inventions accrue to the benefit of his employer.

Where an inventor is a technician engaged in research work he should keep a permanent diary in which dated and signed daily records of his work are entered. When an invention begins to take form in the mind of an inventor, whether he be a casual inventor or a technician engaged in research work, a file relating to this invention should immediately be opened. The first entry in the file should be a record of the date on which it was opened, together with a written description and, if possible, sketches of the invention no matter how hazy, dated and signed by the inventor and by one or more competent witnesses.

It is of importance that an inventor use reasonable diligence in perfecting his invention. Accordingly, to preserve evidence of diligence, complete written records should be entered in the file of each step in the development of the invention and these records should be dated and signed by the inventor and by the same witnesses if possible. When the invention has taken a definite and what appears to be final form a complete written description and drawings should be made, dated, signed by the inventor and witnesses, and entered in the file.

Wherever possible a full size working model of the invention should then be made and it should be successfully operated in the presence of witnesses. A record signed by the inventor and witnesses of the date of making and operating the model should then be entered in the file and if at all feasible the model should be tagged or otherwise identified and preserved for future reference. Instead of making a full size working model of the invention an inventor may promptly file a patent application, both having substantially the same legal significance in determining when an invention has been completed. Under any circumstances an inventor should not delay unduly in filing his application for patent. The file should also contain the full name and address of each witness and from time to time any change in address should be noted.

If the history of the development of an invention is preserved as outlined above, the inventor will have dated records to refresh his recollection and will also have corroborating evidence in the form of documentary evidence and the testimony of disinterested witnesses. In addition to being of value in aiding an inventor to prove that he is the first inventor in the event two or more parties are seeking patents for the same invention, such a file will also prove of value where the inventor did not himself seek patent protection and where someone else, having secured a patent without knowledge of the inventor, brings suit against him for patent infringement. The file will then be a material aid in preparing a defense to the suit and in proving that the patentee was not the first inventor and accordingly not entitled to the patent on which the suit is based.

A carefully preserved record of the history of an invention is accordingly both a shield and a sword. It is a defensive weapon in unjustified suits for patent infringement and an offensive weapon in aiding to establish the patent rights of the real inventor.

GRANULES OF THE SOLAR

Why the Sun's Surface Looks as if it Were Bumpy . . . Granules Found to be About 2200 Miles in Diameter . . . 100 Degrees Hotter Than the Remainder

GALILEO was daring when he first turned his telescope on the sun, for he discovered the spots upon its surface by looking at the dazzling disk directly without any device for weakening the intolerable brilliance. Though positive evidence appears to be lacking, it is only too probable that this zeal in the cause of observation led to his eventual blindness.

Galileo's telescope, with its concave eye-lens like that of an old fashioned opera-glass, did not permit of the simple device so familiar to the modern observer of projecting an image of the sun on a white surface held a foot or so behind the eyepiece. With a convex eyepiece a small change in the focusing screw brings this image of the sun into sharp definition so that sun-spots and all the principal features of the disk may be seen by several onlookers at once. It is strange, however, that the simple device of smoking the outer surface of the telescope objective with the soot from a candle flame did not occur to Galileo. With reasonable care to avoid injuring the lens by heating it, this works fairly well with a small instrument like a binocular, and the soot can be wiped off clean afterwards.

This is, however, a poorish makeshift —Herschel did better by putting at the eye-end a sheet of plane-polished glass set at an angle of 45 degrees. More than 90 percent of the sun's light and heat escape through this, and a shade glass of moderate density will reduce the brightness of the reflected light so that the eye can bear it without danger of breaking the dark glass by over-heating.

FOR more serious work, polarizing devices may be used which permit the reduction of the apparent brightness of the photosphere at will. When the sun's light is thus enfeebled and its surface viewed with a fair-sized instrument under steady air conditions, it is found that, in addition to the conspicuous spots which appear here and there, the general background of the solar disk is not featureless—it appears as a matte surface with a fine and nearly uniform "granulation," so that it looks rather like rough drawing-paper. These photospheric granules have been known for more than a century, but little more than the fact that they exist was understood till within the last 20 years or so. The granules are so numerous and so much alike that it is practicable to follow the fate of individuals only by taking photographs of an enlarged solar image in rapid succession.

The work of Janssen in France, Hansky in Russia, and Chevalier in China, has shown that the average life of a particular granule is only two or three minutes—new ones appearing as the old vanish. They are roundish spots, a few seconds of arc in diameter, and shift but little on the sun's surface—the observed apparent motions of two or three miles per second resulting probably from changes in the relative brightness of various parts of a nearly stationary object. They are found all over the sun's surface, from the equator to the poles, and present substantially the same appearance whether sun-spots are few or many.

A very interesting study of this peculiarity of the solar surface has just been published by Professor H. H. Plaskett of Oxford. He begins with a new and accurate determination of the difference in brightness of the granules and the background between them. It has long been known that this is small, so that careful measures are required; and it is of importance to make such measures with light from regions of the spectrum which are clear of absorption lines, or as nearly so as possible, to avoid the complications which would arise if the lines were stronger in one region than another. Using specially selected regions in the violet, blue, and yellow, and working on photographs taken with powerful instruments at Victoria, B. C., and at Oxford, Dr. Plaskett finds that the extreme range in brightness from the most luminous granules to the dullest parts of the background does not exceed 10 percent. His description of the precautions employed to eliminate the various errors which beset photographic photometry and to allow for the blurring of the image due to imperfect seeing, occupies six pages. The actual measurements and calculations represented by these pages probably took as many weeks.

It appears also that the contrast between the granules and background increases toward the violet, and that it is as great if not greater close to the sun's limb as at the center of the disk. The diameter of the average granule is about five seconds, corresponding to 2200 miles.

Having these facts, it remains to interpret them—which is the main feature of Plaskett's work. The simplest explanation is the correct one: The sun's surface is not equally hot all over and the hottest parts look the brightest. Taking 6000 degrees absolute as the temperature of the background, that of a bright granule comes out 6100 degrees. With such a difference, the contrast should be greater in violet light than in yellow, as it appears actually to be.

SO far, so good: But why should some parts of the sun's photosphere be hotter than others? We can understand easily why the temperature of the gas near the surface of the sun or any other star should increase steadily with depth below any given level, but why it should change laterally is harder to account for. The great flow of energy from the deep interior should be steady, and without some special modifying influence we should expect the apparent surface of a star to be a uniform and featureless blank of dazzling light. But in this case there would be not merely no granulation on the sun's surface but no sun spots. Everyone is familiar with the accepted interpretation for the latter—that they are rising streams of gas ascending from the sun's interior which are cooled by expansion and so appear dark. The belief that a very much milder circulation occurring generally all over the sun's surface may produce the granulation is strongly supported by this latest work.

To produce vertical convection—as such motions are called—in a layer of fluid, some source of power is necessary. In the laboratory this can be secured by gentle heating of the bottom of a wide dish full of fluid. In the earth's atmosphere it is produced on a large but more irregular scale by the heating of the ground by the sun's rays. When the air near the ground gets so hot that an ascending column of it, despite the cooling due to expansion as it rises to regions of lower pressure, will still be hotter and lighter than the surrounding air, the upward motion will go on of itself if the least accident starts it. A

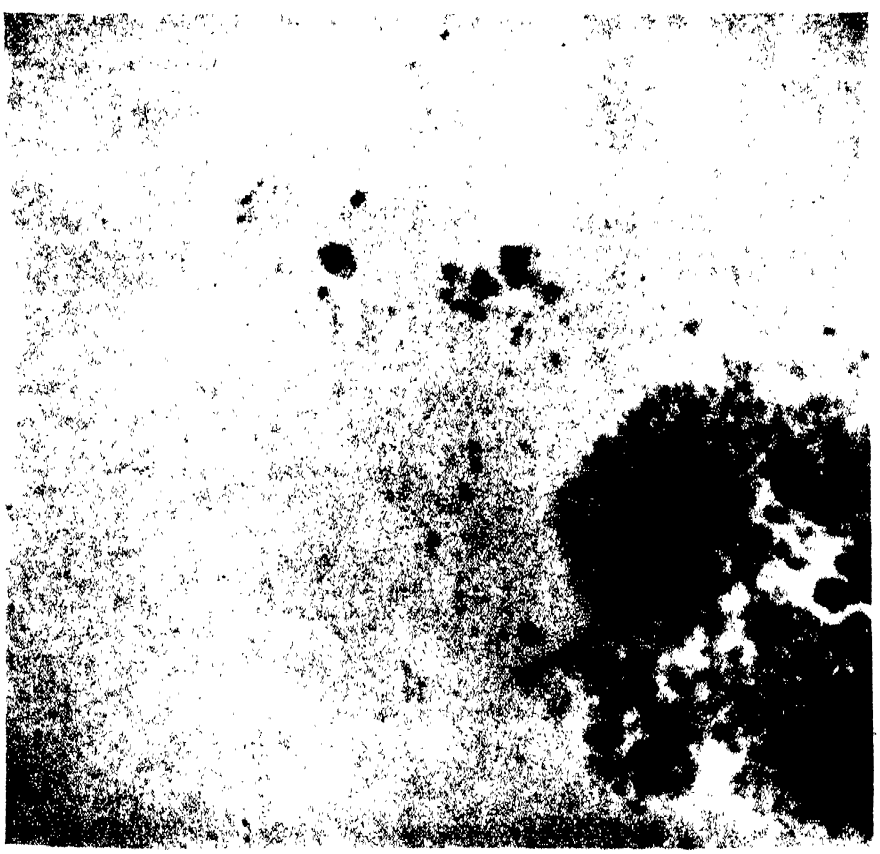
PHOTOSPHERE

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society.

very familiar example is found in the huge ascending columns of damp air which, as the moisture condenses, form our cumulus clouds or "thunder-heads." More violent and fortunately rare motions occur in tornadoes.

Under uniform conditions in the laboratory the convective motion, when gentle, tends to break up the fluid into cells, roughly equal in size, with upward flow in the center and down-flow at the edges, and with diameter about 1½ times the depth of the convective layer. In the air above us we may often see the same thing happening in somewhat less orderly pattern, when the sky is full of isolated, dome-shaped, cumulus clouds. Viewed from far above, such a patchy layer of terrestrial clouds might give a tolerable imitation of the solar granulation except that the latter changes much faster and is on a vastly greater scale, indicating that the layer in which it is produced is about 1500 miles deep.

This depth measured inward from the visible surface of the sun would reach a region where the temperature was very much higher than the 6000 degrees already mentioned. Though we cannot observe such a region directly, we can calculate what would happen there. This was first done by Unsöld, who found that, a thousand miles and more below the surface, the atoms of hydrogen—which form by far the greatest part of the sun's atmosphere—are practically all split up into protons and electrons—that is, ionized. Rising by calculation to higher levels where the pressure and temperature are lower, he found that more and more of the protons and electrons would combine to form neutral atoms, till, at the visible surface, more than 99 percent recombination occurs. Now the combination of the two charged particles to form a hydrogen atom liberates a large amount of energy. In an ascending column of gas, this would produce enough heat to supply the driving power for convection and cause the upward current extending to the level where the recombination was substantially complete. This level is below the visible surface, but the upward motions would persist by mere inertia and might carry the effect well into the directly visible layers. Here and there, in sun-spots, such motions occur on a tremendous scale and with great violence, producing tornadoes thousands of miles in diameter which last for weeks. Ordinarily the effect is mild—a sort of gentle simmering instead of explosive boiling—but even so it reveals itself by the gently mottled character of the sun's whole surface.



A study in contrasts. The umbra of the sun-spot is as much as 2000 degrees cooler than that of the background photosphere, which is at about 6000 degrees absolute, and the contrast is therefore strong. But the difference between the same background and a bright granule is only 100 degrees, and the contrast is not nearly so strong. Even then, much of it is lost in reproduction

IN the sun, of course, there are no clouds—only the gradually increasing haziness due to the presence of electrons and positive ions in the gas: but, nevertheless, the hotter regions look brighter and reveal to us what is happening. Near the sun's apparent limb where our line of sight meets its actual spherical surface obliquely, we cannot see as deep into the atmosphere for our gently-sloping line of sight meets with practically complete obscuration from the haze before it has got to any great depth measured vertically. We therefore get light from cooler regions on the average than we would do if we were looking straight down at the middle of the sun, which explains why the sun's center looks brighter and also bluer than its edge. From exact measures of this "darkening" toward the limb, Professor Plaskett, by another piece of laborious calculation, finds that in general there is a steady fall of temperature outward as the sun's surface is approached from within. Just at the depth from which light begins to escape fairly freely to space through the haze, however, this decrease almost stops, and for a moderate distance the temperature is almost constant, then it falls off rapidly to the boundary value. This is just what might be expected if the heat-carrying streams of gas extended well into the observable levels where the haze is thin. There is good reason to believe that, when highly precise measures of the distribution of brightness over all parts of the sun's disk have been made with light of many wavelengths, it will be possible to work out the properties of the outer layers of the sun much more accurately than we now know them, and extend the calculations to levels far too deep in the haze to be seen directly.—*Lake Minnewaska, New York, June 3, 1936.*

Courtesy American Airlines

Aircraft Grow Larger

Efficiency Increases With Size . . . 55-Ton Flying Boats Designed . . . 80-Ton Next . . . Promenade Deck in Wings . . . Daily Service to Europe

By REGINALD M. CLEVELAND

ONE of the most significant developments of air transport is the increasing size of units and the definite certainty that still larger planes will shortly find their place in the air lanes, both over land and over sea. Having fledged their wings to a point which makes possible a high degree of reliability of operation coupled with speed at least three times that of surface transportation, passenger liners for the overland route and flying boats for the overseas services, which, before the year is out, will bring both major oceans into the scheduled airline map, are ready to expand in dimensions for increased comfort and increased economy.

This step has had to wait upon the development and satisfactory testing of larger power units than have heretofore been available. Now, however, in the engine factories of the United States and Europe, air-cooled engines of single- and double-row radial types, developing in excess of 1000 horsepower, are ready to be mounted in more widely spreading wings. On the Continent and in Great Britain much progress has also been made in liquid-cooled engines developing 1000 or more horsepower. In Germany, Diesel engines of more than 800 horsepower are flying, and larger sizes appear to be imminent.

Diesel experimentation is by no means at a standstill in the United States. At the eleventh annual engineering conference of the National Advisory Committee for Aeronautics, held at Langley Field, Virginia in May, a four-cycle Diesel cylinder was demonstrated, operating at 2000 revolutions per minute and showing cylinder pressures per cubic inch of displacement closely comparable with those of the newest 1000 horsepower spark ignition engines. There is also heartening progress quietly being made towards the utilization of steam reciprocating and turbine prime movers for aircraft.

In the United States, the availability of 1000 horsepower air-cooled engines has already put air transports of increased size and roominess into the air. American Airlines is now operating some of its fleet of expanded Douglas twin-engine transports, designated as DC-3 when used as 24-passenger day planes and as DST when used as 16-passenger sleepers. For this company, these planes are powered with 1000 horsepower single-row Wright Cyclone engines. United Airlines has purchased eleven similar ships, powered with the new Pratt and Whitney 14-cylinder double-row Hornets, which are rated at 1000 horsepower for takeoff and have pro-

duced 1150 horsepower on the test stand. The line will emphasize the comfort made possible by the increased fuselage dimensions of this ship by carrying only 14 passengers as a day plane, and providing them with completely revolving arm chairs and a sense of spaciousness not heretofore attained on the airways of the United States.

More significant in its implications for the scale of the air vehicles which we are soon to use than this transition twin-engine craft, however, is the still larger Douglas DC-4. After about a year of consultation, five major airlines—United, Transcontinental and Western Air, American, Eastern Air Lines, and Pan-American Airways—have combined to write the specifications of this four-engined giant.

Seeking a plane in which passenger capacity and range at speed would make possible an economic operation, even without the uncertainty of airmail contracts, these groups decided to pool their interests, called into consultation Edward P. Warner, former Assistant Secretary of the Navy for Air, and noted authority on airplane design, and produced requirements for a super-liner which needed nearly 200 typewritten pages of specifications to describe. Under these specifications, a contract for a prototype plane to cost about 500,000 dollars was let with the Douglas Company. Should its performance characteristics live up to expectations—and there is no reason to believe that they will not—it is anticipated that about 60 planes, representing a total investment of around 12,000,000 dollars, will be ordered.

THE DC-4 will be a low-wing monoplane with four engines, of at least 1000 horsepower each, streamlined into the leading edge of its wings. It will be able to cross the continent with 20 passengers in comfortable staterooms by night with a single stop or, as a day plane for 40 passengers, to make the crossing with two stops for fuel. Its cruising speed is expected to exceed 210 miles an hour, but emphasis has been placed upon extreme comfort, spaciousness and soundproofing, coupled with range, rather than excessive speed. Twelve-hour crossings from coast to coast in either direction should be readily attainable and it is held that true dinner-to-breakfast service between any of the major cities of the United States is sufficient to meet all reasonable demands for rapid transportation. The first plane of this class will probably be delivered for tests early next year and may even get into the air before the end of 1936, while deliveries on duplicates are expected in impressive quantities in 1937.

Not only are the five members of the Air Transport Association of America who combined in this striking project convinced that true economy of airline operation lies in larger units, but they feel that every reasonable device for safety, dependability, and passenger comfort which could be anticipated during the next five years, has been incorporated in their specifications. For this reason they believe that one of the costly bugaboos of air transport to date, namely quick obsolescence of perfectly good and flyable equipment with the appearance of some new type—only slightly improved in some minor characteristic—will be eliminated.

The idea of larger aircraft is not confined to the United States. The ill-fated giant, *Maxim Gorky*, is to be repeated in Russia; France has successfully flown a comparatively slow but efficient flying boat of 70,000 pounds; construction is progressing on the Dornier DO-20, a flying boat of 58 tons gross weight. This is an eight-engined monoplane with the interesting innovation of having each pair of engines drive a single three-bladed air screw.

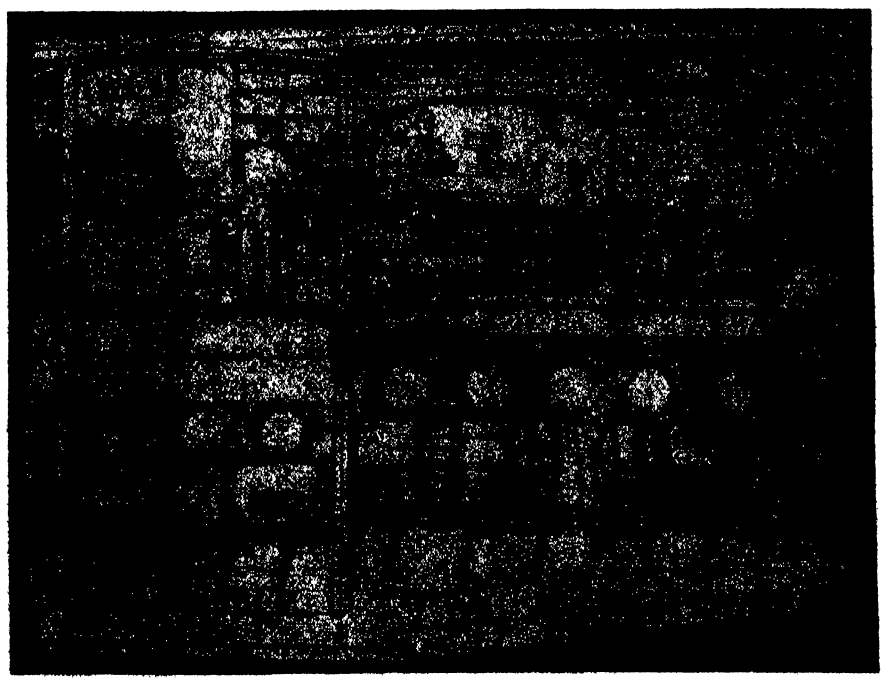
Aerodynamic research recently carried forward by the N.A.C.A. and other scientific bodies shows indisputably that the efficiency of aircraft increases rather than decreases with size. Lift and drag characteristics are definitely better proportionately for large aircraft than for small, and the limit of size from this point of view is by no means in sight. The economic argument for large craft may be presented somewhat as follows: The complete useful load per horsepower and per cost of plane has a tendency to remain reasonably constant, but bigger ships, under identical conditions of distance, will be faster and therefore produce a greater traffic turnover; in the long run, the reliability of operations, and therefore the dependability of service, is better with two engines than with one, and still better with four than with two.

As time goes on, the number of crew and cost of equipment needed for ground operations of any size of aircraft tends inevitably to grow. A crew equipment of less than three is already little considered for long hauls; over land, a pilot, co-pilot, and steward or hostess; over water a pilot, navigator, and radio man. In the last named case, this is less than the minimum on long-haul operations, and Pan-American, in the Pacific, is operating with a crew of six. However, the same crew can with equal efficiency operate a plane for 40 passengers as for 14, in land operation at least, plus the possible addition of a steward, and it is evident that the crew cost per passenger goes down with an increase of passenger accommodations.

FOR long range overseas operation—for example, non-stop flights between the United States and Europe—it is evident that a double shift of crew must be provided, so that fresh watches may be maintained. This obviously presupposes a large ship, accommodating many passengers.

Finally, it goes without saying that the bigger ship offers the higher degree of comfort and is therefore the more attractive to passenger traffic.

It is in the field of the ocean-going plane that increases in size are likely to be felt the most. Both Glenn L. Martin and Igor I. Sikorsky, designers of the Clipper ships for the South American and Pacific services, are ready with complete plans for flying boats at least twice the size of their present flying product. Both believe that such craft are indi-



Part of the interior of the proposed Sikorsky 55-ton flying boat, showing the double-deck arrangement, staterooms, the galley, and storage space forward

One of the Short flying boats designed for Imperial Airways of England. In size this four-engined ship is between the present Martin and Sikorsky Clippers

cated by the demands of the ocean services, especially in the Atlantic, and fully justified by the traffic in sight.

Mr. Sikorsky has worked out to the last detail the structure of a 55-ton six-engined flying boat, capable of carrying 48 passengers in extreme comfort and a crew of ten or eleven non-stop between the United States and Europe in 24 hours. Indeed, wind tunnel tests of many of the elements of this ship have already been made. With two decks, its roomy hull would include not only staterooms of adequate size and restful furnishings, but a dining and dancing room 15 by 15 feet, from which a circular stairway leads to a hanging balcony above. Here the root sections of the thick wings are used to give additional beam to the apartment and form alcoves in which are a bar and settees. Windows let into the lower surface of the wing make it possible to look directly downward at the sea.

IN this design there is already sufficient headroom in the wing to provide ample working space within the nacelles behind each motor so that minor adjustments, such as those to fuel lines, ignition systems, and other accessories —which, after all, are the things which need adjustment in 99 cases out of 100, rather than the major elements of the engines themselves—can be made on any engine during flight. A narrow gage track bearing a small sliding car runs out into the wings and facilitates access even to the outboard motors.

The famous Russian designer does not believe, by any means, that ocean-going aircraft will stop at 55 tons. When a weight of 80 tons is reached, leading edges of the wings, he says, will already be so thick as to provide space for a promenade deck, and he is firmly of the conviction that flying boats up to 150 tons or more will be the product of this generation, and up to perhaps 500 tons the product of the next.

One basis for this opinion, and the equally firm conviction of Mr. Martin and other designers of large boats that craft will increase in size, is the fact that water operations lend themselves particularly well to big craft. The limitations upon land, it is admitted, lie not so much in the design and construction of huge aircraft themselves, but in the landing and takeoff facilities at airports, more especially those at high altitudes. Water-going craft have the advantage of taking off and landing always at sea level, which means slower speeds for both these critical operations. Ample room is at hand in the principal harbors of the world for craft of any size.

The principal desiderata are range, which is plainly in sight with the increased aerodynamic efficiency of big craft and will be further extended as soon as oil-burning power plants have reached the stage which is shortly foreseen; reasonable ceiling, so that operation may take place above the normal storm area at approximately 18 to 25,000 feet, where the complications of pressure cabins will not be necessary and slight additions to the supply of available oxygen in the cabin will make passengers thoroughly comfortable; and cruising speed of around 200 miles an hour which can link the Old World with the New between sunrise and sunrise, and bring within the span of a week a return trip from New York to almost any seaboard city in the world.

When it comes to the question of flying boat as against airship operation for Atlantic service, Mr. Sikorsky is naturally very much in favor of the large, heavier-than-air craft. As to the comparative cost in capital outlay and in personnel required for the two types of services, he postulates the following figures:

	Airship	Seaplane
Number required for daily service	8	8
Total cost of equipment	$32 000 000	$6,000,000
Main Terminals	2	2
Cost of main terminals	$2,000,000 each	$750,000 each
Auxiliary terminals	4	4
Cost of auxiliary terminals	$100 000 each	$25,000 each
Flight crew	320 total	80 total
Main terminal crews	100 to 200 men each (200 to 400 total)	50 men each (100 men total)
Auxiliary terminal crews	100 to 200 men each (400 to 800 men total)	5 men each (20 men total)

"Thus we may easily see that the first cost of a daily airship transoceanic service would greatly exceed that of a daily seaplane service," he said. "The capital outlay for equipment and operation terminals is estimated roughly at 36,400,000 dollars for airship service against some 7,600,000 dollars for a seaplane service. Operating personnel including flying and ground crews is estimated between 920 and 1520 men for an airship service against 200 men for a seaplane service.

"The seaplane service indicated in the table is satisfactory for two daily departures," Mr. Sikorsky declared. "In both cases it would thus be possible to have a daily operation carrying 60 passengers across the ocean in both directions. While it is claimed that the dirigible will have a greater capacity for carrying mail and express, we believe that the 4000 to 5000 pounds of mail that could be carried by the daily flying Clippers appears sufficient, and that considerable advantage in speed would more than compensate for the loss in carrying capacity.

"TO make a transoceanic airmail service really valuable it must be a daily service in both directions. After an airmail letter is mailed in New York any day before noon, it should reach Europe the next afternoon and be taken within a few hours by local airmail to almost any of the important cities. If this is not the case and an airmail letter may happen to wait several days before departure of an aircraft, the service across the Atlantic would lose most of its value with respect to pioneering and study.

"The airplane service is certainly more flexible and faster than an airship service," he concluded, "and from an economical viewpoint would appear more practical."

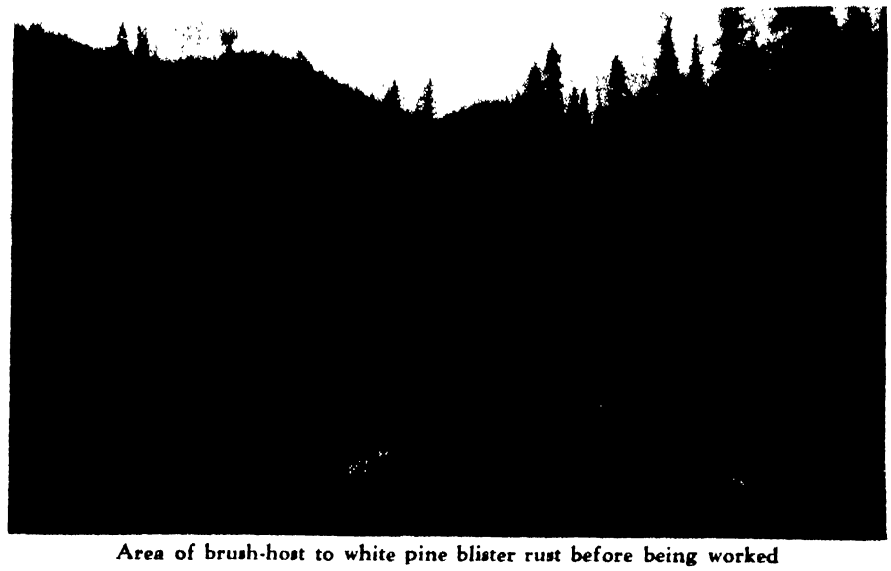
Fighting Fungi With Fire

ONE of the most serious menaces to our pine forests is white pine blister rust. This fungous disease, which kills both white and five-needled pines, cannot spread directly from pine to pine, but passes an intermediate stage of development on currant and gooseberry bushes. These bushes may be infected by spores traveling distances up to 200 miles, but, fortunately, pines can be infected only by the spores from these host bushes within a distance of a few hundred yards. To protect stands of pine from this menace is, therefore, relatively simple; it is necessary only to destroy such bushes in proximity to pine forests.

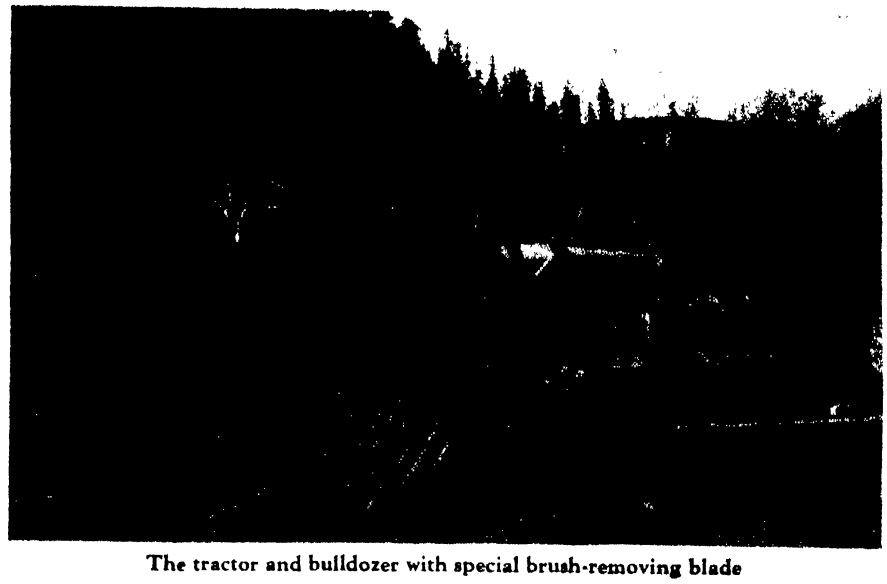
The Civilian Conservation Corps has done considerable blister rust control work, for the most part by the hand-pulling method. In the west, however, this method was found to be impracticable in the dense masses of bushes growing in heavy brush along streams where the most susceptible species of currant and gooseberry bushes are found. Chemicals were tried, but while the wild black currant could be killed in this manner, no chemical was ever discovered that would satisfactorily control the white-stemmed gooseberry.

THE eradication of this species, found especially in the Coeur d'Alene and Kaniksu National Forests in North Idaho, proved quite a problem. This was solved by development of the bulldozer method of eradication. A blade was designed especially for brush removal to be attached to a bulldozer on a tractor. This blade is pushed into the ground just below the surface and, as the tractor moves forward, the brush is uprooted. Piled into windrows, this brush is burned after the danger of forest fire is passed. Cleaned areas are then sown to grass in order to inhibit the recurrence of the white-stemmed gooseberry bushes. Experience has shown, however, that there is very little tendency for these bushes to come back in the cleared area between the windrows. Any bushes which recur where the brush was burned can be readily pulled by hand.

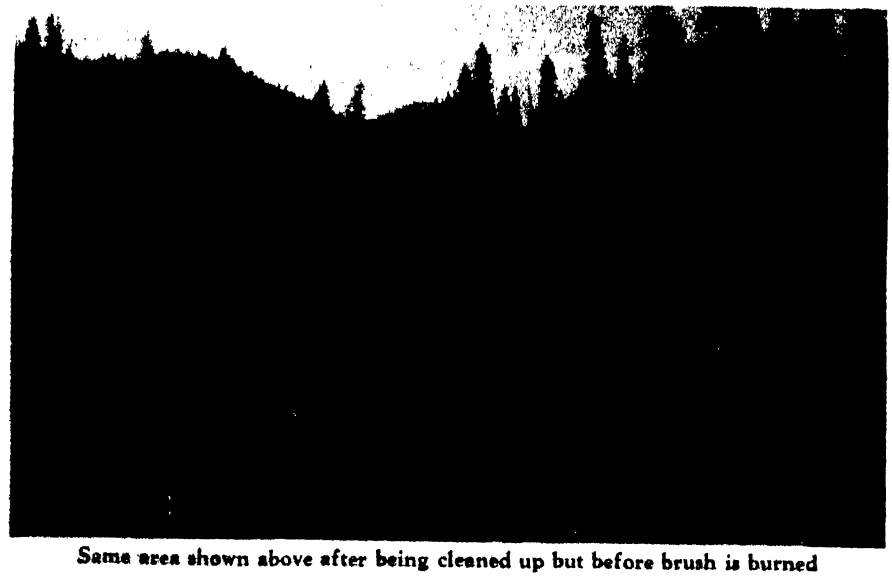
While the bulldozer method is more expensive than either the hand-pulling or the chemical spray method, it is most efficient in areas where the white-stemmed gooseberry occurs in large numbers and where the brush is too heavy for effective eradication by any other method.



Area of brush-host to white pine blister rust before being worked



The tractor and bulldozer with special brush-removing blade



Same area shown above after being cleaned up but before brush is burned

Bronze Age Blondes

Ancient Wooden Coffins in Denmark . . . Buried for 3000 Years . . . Dress, Art, and Customs Revealed . . . Tannic Acid Kept the Treasure Intact . . . Priestess?

By SOPHIE WILDS

A FEW months ago an old, hollow log, buried for thousands of years, was excavated at Skrydstrup, a little hamlet in the south of Jutland, Denmark. Today this yawning tree trunk (Figure 1), a veritable treasure chest, lies in the National Museum at Copenhagen, still unexplored, although its contents are known to be of inestimable value. It awaits the skilful but very busy hand of an expert in the museum, to be opened and examined. The lid has been removed, disclosing the general outline of a figure—a woman with fair hair, held in a net of woven ribbons, the shape of whose face and body can be distinguished. It will be some months before authorities can reveal the details.

I came upon a similar coffin (Figure 2) that had been opened and was recently on view in the new wing of the Copenhagen Museum. The body which had lain in that black log was clothed in garments also on exhibition. They were perfectly preserved. Because they seemed the last word in sport styles I doubted their authenticity. Was it possible that this simple costume, almost unimpaired, had actually been worn hundreds of years before the dawn of history. This is the story that archeology has managed to piece together.

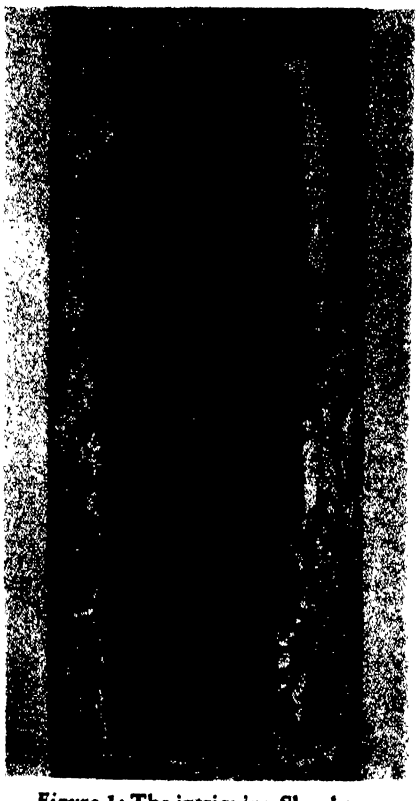


Figure 1: **The intriguing Skrydstrup find which remains to be unwrapped**

Nearly 3000 years ago on the peninsula of Jutland, a blond, slender, bobbed-haired young woman died. They laid her to rest in that skilfully hollowed oak tree trunk. On a foundation of small stones the chest rested. Upon it was heaped a high mound of loose meadow ground and sandy earth. Since about 1000 B.C. this 14-foot barrow at Egtved (a small village in the southeastern part of the peninsula), like innumerable other such monuments, had guarded its secret. When the burial mound was cleared away and the box was opened that dim Bronze Age in which the young woman had lived was vividly recalled.

THE intelligent Egtved farmer on whose property the chest was found voluntarily consigned the precious box to museum authorities, who subsequently spent many days in unwrapping the bundle within—a job as difficult as it was exciting.

Above all other objects found in the chest the most remarkable is the woolen dress interwoven with stag hair, according to Dr. J. Broendsted, Curator at the National Museum in Copenhagen and authority on prehistoric times. To be sure, it is not the only wooden coffin to yield, Pandora-wise, dress of ancient date. It is, however, to the "one man" tombs of wood, built in the later Stone and the Bronze Age, that we owe the preservation of both men's and women's costumes. These are of an earlier date than any other clothing as yet discovered in Europe and the dress of the Bronze Age is the oldest preserved domestic dress in the world.

The excitement and enthusiasm attendant upon opening a chest can easily be imagined. The lid fits closely,

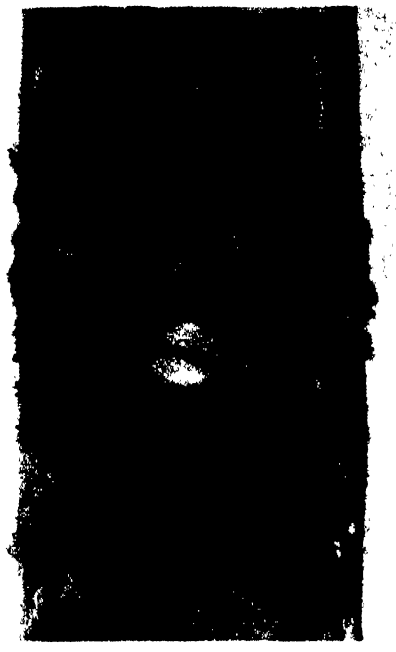


Figure 2: **Remains of the blonde from Jutland peninsula, Denmark**

an oak tree trunk having been dexterously split and scooped out to admit the reception of its contents which were then closed up and lost to view. With what care this cover is pried open and removed! Within the Egtved coffin, first to be seen were the loose hairs (all that was left) of a cowhide which had been originally fastened together around the body. The hide itself had completely disappeared. Spreading a retaining foundation over the easily scattered hairs, the museum authorities gently removed the first wrapping. There before their eyes lay the outlined figure of a woman's body under a heavy woolen blanket. She had been placed in the hollowed-out trunk on her back, resting on the fur side of the cowhide.

To those versed in archeological interpretations every minute detail is eagerly seized upon. So it was with enthusiasm that they spied a little yarrow flower just under the lid. Silently they blessed that wanton gust of wind which must have fanned the flower into the chest before it was closed, life's last protest against grim death. The tiny flower had now become a bit of reliable evidence. It proclaimed summer to have been the season of the year when interment took place.

Only a single wrapping now hid the body itself from the archeologists' sight. Tenderly, even reverently, this was now laid aside. This woman envoy from ancient days had blond hair, now stained

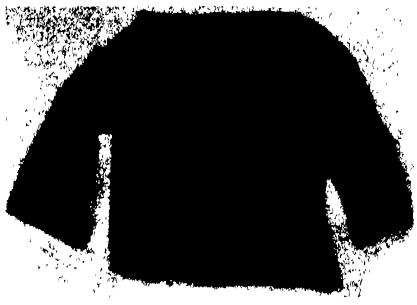


Figure 3: **The lady's woolen blouse must have been somewhat scratchy**

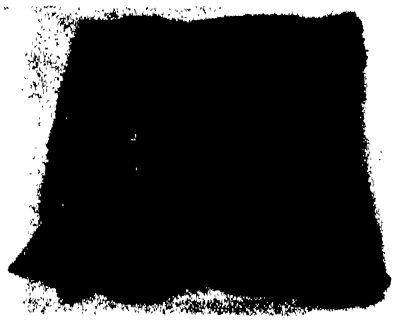


Figure 4: **The skirt, marvelously preserved and in the 1928 style**

by the tannic acid of the oak coffin. Cut short in a straight line across the forehead and slightly longer at the side, it had been held in a hair net of woven ribbons. Her brown woolen dress is in two pieces—elbow-sleeved blouse (Figure 3) reaching somewhat below the waist and knee-length skirt of fringes (Figure 4), twisted double, held together at top and bottom by bands. These, together with a beautifully woven belt at the waist and a chased, bronze belt plate, contrived to produce the effect of a startlingly modern costume, well adapted for sports. Nor did the lady lack shoes, crude and primitive though these rag ones were. For ornaments, besides the belt plate, she had a tiny bronze earring and bronze bracelets which clasped both wrists.

What was in that bundle at her side? The beaker at her feet, what had it contained?

Soberly, content to solve one problem at a time, the archeologist-detectives set slowly about their task of unraveling the mysteries before them. With so many well preserved objects to guide them, it was possible to recreate the past in some detail.

This young woman's age was easily estimated by the teeth and, although the bones had entirely disappeared, such objects of wearing apparel as were present lay in the original position which they had occupied centuries ago when enfolding her body. Thus her height could be computed. A belt, knotted around her waist, served to measure her girth.

Who she was, in what manner she had lived, cannot be accurately concluded. Archeologists do not hesitate to place the period in which she lived at about the year 1000 B.C. She was a lady of the Bronze Age. The belt plate decorated in spirals testifies to that, says Dr. Broendsted. But who has ingenuity enough to interpret the story of the dress? Was it a summer costume, an indoor garment, or had it some religious significance?

Other samples of clothing have come down from the Bronze Age; little bronze figures, too, representing women kneeling, standing, bending over backward, and wearing the short fringed skirt. It is thought that these figures may be small models of idols or priestesses and their costume a ceremonial garment.

If that be so, suggests Dr. Broendsted, then the Egtved woman may have been a priestess. He advises us that this is nothing more than conjecture, however, without adequate proof. There is just as much reason to believe that, far from representing some occupation or calling, the garment may simply be the kind worn in summer (the season in which the body was interred), or the style adapted for house wear. It is well known that Eskimos dress lightly indoors.

Material is too insufficient as yet to provide a key to the riddle. Possibly new clues will be found in the Skrydstrup bundle—new clues and perhaps also new problems.

THE birch bark beaker in the Egtved find had contained an invigorating drink to fortify the departed. Analysis of the remaining deposit revealed its ingredients to have been whortleberry, honey, and sweet gale. That was an easier puzzle to solve than the one posed by the other remarkable content of the chest, the cloth bundle which, when opened, was found to contain the burned bones of a seven- or eight-year-old child —the little daughter of the woman, perhaps? Who can tell? Why was the child cremated when the woman was buried? Insoluble problems.

Just as the transition from wandering nomad to settled farmer, which in Denmark occurred about 2500 B.C. to 2000 B.C., marked a significant period of history, so this change in burial customs represents a drastic innovation. From time immemorial primitive man, in his fear of death with its accompanying dread of complete oblivion, bent all his energies to outwit the enemy. Nothing was so abhorrent to him as the idea of obliteration, of being snuffed out and forgotten. Every known means was requisitioned to defy this horrible fate; food and drink placed by the body of the departed; the body itself carefully dressed as in life and interred, first underneath the earth to be near the living, and in later ages in monumental stone sepulchers which served as constant reminders of the dead—everything was done to impart at least the semblance of life to the remains of the departed dead.

How was it, then, that so startling a change occurred? This new custom of deliberately destroying the body by fire was diametrically opposed to the instinctive desire for its preservation so apparent up to that time. Dr. Broendsted reminds us that the dissolution of the body had meant the annihilation of the individual. Did cremation indicate a changed attitude, a disbelief in immortality? Surely the implication of such an iconoclastic view must be wrong. No, the explanation lies in a new and wholly different attitude toward death. Scholars believe that it marks the introduction of a new religious concept stemming from a southern invasion—namely this, that the soul is separate from the body and that the death of the latter does not end the everlasting life of the individual spirit. Quite the contrary, in fact, since by destroying the body the soul may be liberated. This must have seemed logical.

Due to this new faith the graves of the later Bronze Age people have been valueless, archeologists say, containing as they do nothing but ashes. Earlier people built better than they knew. Believing in the continuity of life they had so successfully demonstrated their triumph over death that many hundreds of years later their spiritual resurrection miraculously took place. When last year a young woman posed (Figure 5) in a newly made costume, constructed after the pattern of the original, and designed for the opening of the new wing of the Museum, intervening centuries rolled away: the Lady from the Bronze Age came to life, revealing what manner of people she represented by the quiet simplicity of her dress—a quiet simplicity still to be found in Denmark.

Figure 5: **A modern copy of the blonde's costume of 3000 years ago**

LIQUID-PROPELLANT ROCKET

THE author of the accompanying article is the dean of scientific experimenters on the high-efficiency rocket as a means of propulsion wholly independent of the air—a reaction motor. He began theoretical work in 1912 when an instructor in physics at Princeton, patented a "rocket apparatus" in 1914 (U.S. Patents No. 1,102,653 and 1,103,503), made actual experiments in 1915 when an assistant professor of physics at Clark University, and in 1919 the Smithsonian Institution published his first progress paper, "A Method of Reaching Extreme Altitudes," describing his preliminary experiments. He is now Director of the Physics Laboratory at the same university.

The accompanying paper is published by permission of the Smithsonian Institution, and is Dr. Goddard's second official progress paper on his work. It is conservative; the author never has been inclined to rush into print with hopes and great expectations, and even now he describes only what has actually been accomplished in his experiments. In a recent editorial comment, *Nature* (London), the world's foremost non-popular journal of general science, states: "It is good to hear that such experiments are being carried out, and the sober objectivity of Dr. Goddard's work presents a sharp contrast to the unscientific imagination exhibited by those who seek to direct attention to the advent of interplanetary travel before the preliminary investigations that might throw light upon its possibility or otherwise have been completed." Some other writers on rocketry are far ahead of Dr. Goddard and almost, in fact, on Mars already—in books.—*The Editor.*

(In Two Parts—Part 1)

THE following is a report made by the writer to the Daniel and Florence Guggenheim Foundation concerning the rocket development carried out under his direction in Roswell, New Mex., from July 1930 to July 1932, and from September 1934 to September 1935, supported by this Foundation.

This report is a presentation of the general plan of attack on the problem of developing a sounding rocket, and of the results obtained. Further details of the work will be set forth in a later paper, after the main objects of the research have been attained.

Figure 1: The first liquid oxygen-gasoline rocket, in the frame from which it was fired

In a previous paper[1] the author developed a theory of rocket performance and made calculations regarding the heights that might reasonably be expected for a rocket having a high velocity of the ejected gases and a mass at all times small in proportion to the weight of propellant material. It was shown that these conditions would be satisfied by having a tapered nozzle through which the gaseous products of combustion were discharged,[2] by feeding successive portions of propellant material into the rocket combustion chambers,[3] and further by employing a series of rockets, of decreasing size, each fired when the rocket immediately below was empty of fuel.[2] Experimental results with powder rockets were also presented in this paper. [Out of print. See at libraries.]

Since the above was published, work has been carried on for the purpose of making practical a plan of rocket propulsion set forth in 1914[3] which may be called the liquid-propellant type of rocket. In this rocket, a liquid fuel and a combustion-supporting liquid are fed under pressure into a combustion chamber provided with a conical nozzle

Figure 2: An assistant igniting the rocket shown in Figure 1, by torch

through which the products of combustion are discharged. The advantages of the liquid-propellant rocket are that the propellant materials possess several times the energy of powders, per unit mass, and that moderate pressures may be employed, thus avoiding the weight of the strong combustion chambers that would be necessary if propulsion took place by successive explosions.

Experiments with liquid oxygen and various liquid hydrocarbons, including gasoline and liquid propane, as well as ether, were made during the writer's spare time from 1920 to 1922, under a grant by Clark University. Although oxygen and hydrogen, as earlier suggested,[4] possess the greatest heat energy per unit mass, it seems likely that liquid oxygen and liquid methane would afford the greatest heat value of the combinations which could be used without considerable difficulty. The most prac-

[1] Smithsonian Miscellaneous Collections, Vol. 71, No. 2, 1919.
[2] U. S. Patent, Rocket Apparatus, No. 1,102,653, July 7, 1914.
[3] U. S. Patent, Rocket Apparatus, No. 1,103,503, July 14, 1914.
[4] Smithsonian Misc. Coll., Vol. 71, No. 2, 1919.

DEVELOPMENT

Development Carried Out in New Mexico . . . The Fuel Was Liquid Oxygen and Gasoline . . . Col. Lindbergh, and Then Others, Became Interested

By ROBERT H. GODDARD
Director of the Physics Laboratory at Clark University

tical combination, however, appears to be liquid oxygen and gasoline.

In these experiments it was shown that a rocket chamber and nozzle, since termed a "rocket motor," could use liquid oxygen together with a liquid fuel, and could exert a lifting force without danger of explosion and without damage to the chamber and nozzle. These rockets were held by springs in a testing frame, and the liquids were forced into the chamber by the pressure of a non-inflammable gas.

The experiments were continued from 1922 to 1930, chiefly under grants from the Smithsonian Institution. Although this work will be made the subject of a later report, it is desirable in the present paper to call attention to some of the results obtained. On November 1, 1923, a rocket motor operated in the testing frame, using liquid oxygen and gasoline, both supplied by pumps on the rocket.

In December 1925 the simpler plan previously employed of having the liquids fed to the chamber under the pressure of an inert gas in a tank on the rocket was again employed, and the rocket developed by means of these tests was constructed so that it could be operated independently of the testing frame.

The first flight of a liquid oxygen-gasoline rocket was obtained on March 16, 1926, in Auburn, Massachusetts, and was reported to the Smithsonian Institution May 5, 1926. This rocket is shown in the frame from which it was fired, in Figure 1. Pressure was produced initially by an outside pressure tank, and after launching by an alcohol heater on the rocket.

IT will be seen from the photograph that the combustion chamber and nozzle were located forward of the remainder of the rocket, to which connection was made by two pipes.

Figure 2 shows an assistant igniting the rocket, and Figure 3 shows the group that witnessed the flight, except for the camera operator. The rocket traveled a distance of 184 feet in 2.5 seconds, as timed by a stop watch, making the speed along the trajectory about 60 miles per hour.

Other short flights of liquid oxygen-gasoline rockets were made in Auburn, that of July 17, 1929, happening to attract public attention owing to a report from someone who witnessed the flight from a distance and mistook the rocket for a flaming airplane. In this flight the rocket carried a small barometer and a camera, both of which were retrieved intact after the flight (Figure 4). The combustion chamber was located at the rear of the rocket, which is, incidentally, the best location, inasmuch as no part of the rocket is in the high velocity stream of ejected gases, and none of the gases are directed at an angle with the rocket axis.

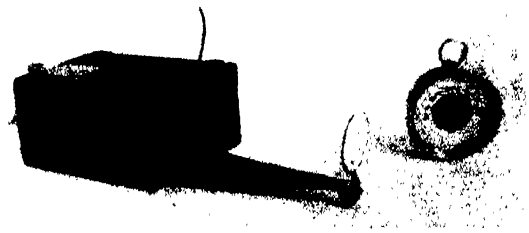


Figure 4: **The barometer and camera carried by the rocket and safely retrieved after the flight**

During the college year 1929-30 tests were carried on at Fort Devens, Massachusetts, on a location which was kindly placed at the disposal of the writer by the War Department. Progress was made, however, with difficulty, chiefly owing to transportation conditions in the winter.

At about this time Col. Charles A. Lindbergh became interested in the work and brought the matter to the attention of the late Daniel Guggenheim. The latter made a grant which permitted the research to be continued under ideal conditions, namely, in eastern New Mexico; and Clark University at the same time granted the writer leave of absence. An additional grant was made by the Carnegie Institution of Washington to help in getting established.

It was decided that the development should be carried on for two years, at the end of which time a grant making possible two further years' work would be made if an advisory committee, formed at the time the grant was made, should decide that this was justified by the results obtained during the first two years. This advisory committee was as follows: Dr. John C. Merriam, chairman; Dr. C. G. Abbot; Dr. Walter S. Adams; Dr. Wallace W. Atwood; Col. Henry Breckinridge; Dr. John A. Fleming; Col. Charles A. Lindbergh; Dr. C. F. Marvin; and Dr. Robert A. Millikan.

(To be concluded)

Figure 3: **Group that witnessed the flight of the rocket shown in Figure 1, except the member who took the photograph. The author stands between the other two**

CONDITIONED AIR?

What *is* Air Conditioning? . . . Newer Concepts . . . Present Status . . . Design Trends . . . Complex Problems of Heating, House Insulation Involved

By PHILIP H. SMITH

IT is still impossible to predict the day when air conditioning will be as commonplace as the bathtub in the American home. Air conditioning has made steady progress, but *sound* growth precludes a quick and unlimited expansion to create in this the new, major industry, new employment, and the boom times for which many persons hoped.

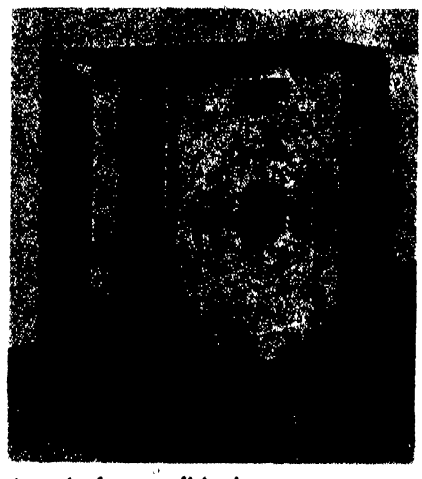
This failure to become an economic pick-me-up overnight is a good thing from every standpoint. Expectations of progress were based upon wild estimates rather than inherent possibilities and this is readily apparent to anyone who understands what a complex engineering problem air conditioning involves.

What is air conditioning? To you it probably means the cooling of indoor air. To the commercial producer of conditioning equipment it means almost everything but cooling, while the engineer regards it as a complex problem of treating air in relation to factors of heat, moisture content, and many others, with due consideration to a host of variables connected with installation and operation of equipment. Confusion as to terms is a notable feature of the talk about air conditioning; hence a sound definition is a required basis for any informative discussion.

Faced with the fact that a few opportunists were calling an electric fan an air conditioner, the National Better Business Bureau evolved a definition which is generally accepted. It declares that in air conditioning the minimum requirements for winter are: the heating, humidification, and circulation of air; for summer: the cooling, de-humidifying, and circulation of air; while year-around conditioning calls for a combination of both. As a further qualification, it is stated that the functions required by the seasons should be performed automatically and simultaneously to suit the requirements of the user.

THE Bureau's definition is excellent as safeguarding the consumer from buying equipment which does not condition, but it must not be assumed therefrom that an increase in physical comfort cannot be had from equipment which falls somewhat short of meeting the definitions. There are excellent devices on the market which will improve atmospheric conditions without contributing *full* conditioning. There is a new, if transitional, concept of air conditioning.

The public's first experience with air conditioning was a chill blast and that effect "conditioned" many people's conception of it. Conditioning became synonymous with lowering of temperatures, yet today, cooling is a minor phase of conditioning enterprise except in public buildings. Concurrently with the development of conditioning equipment has come a modification of the concept of conditioning from the theoretical standard of what a dwelling temperature should be, to what is actually required by the body for its comfort—comfort being a relative matter. This new concept has minimized the importance of cooling as a feature of air conditioning.

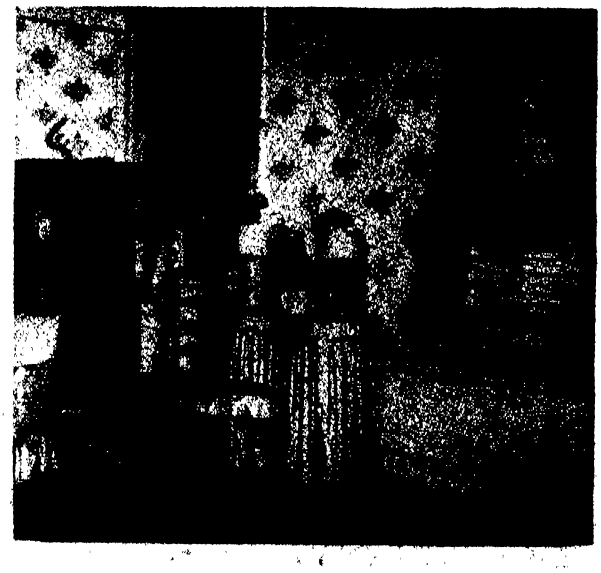


A unit for conditioning the air of a single room. This small, compact type, similar to several produced by different companies, is simple in operation, needs little attention

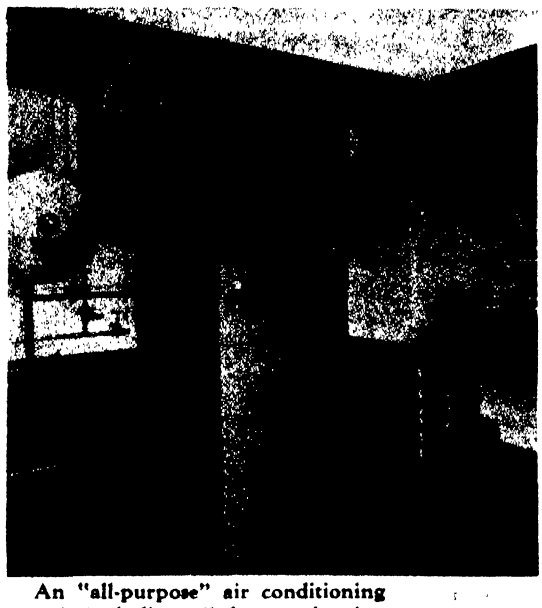
Air conditioning today lays stress on circulation, filtration, and water content of air, as expressed by the functions of humidification and de-humidification. Cooling has become an adjunct. The reasons for this newer viewpoint of air conditioning are threefold: technical, economic, and physiological.

Of the first reason, this much can be said: Full air conditioning, which embraces cooling, requires proper house construction for efficient and satisfactory performance. If a house is not properly insulated, there can be no adequate control of the air within it. Most houses are not so constructed and if equipment manufacturers and installators were to limit their efforts to designing and selling equipment for properly built homes, their market would be limited to the new construction field—an almost negligible market.

The economic angle permeates all considerations, but there is one slant on it which is outstanding. At the present time, to add cooling to the other functions of air conditioning increases equipment cost 50 percent and more.



A "conditioner" of a different type for a specific use, shown in the window. This one does a triple job of filtering and circulating incoming air and silencing outside or street noises



An "all-purpose" air conditioning unit including oil furnace heating

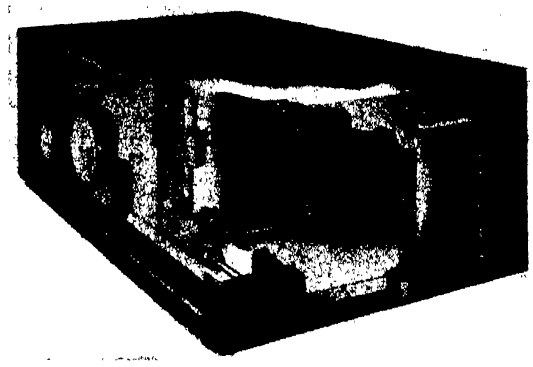
Now if we realize that a maximum use of cooling amounts to little more than 600 hours in the year, this demands that the consumer pay heavily for the slightly added comfort to be had in one-fifteenth of the year. Such facts discourage the consumer from pursuing cooling, once such facts are recognized.

Given the two facts—that most dwellings are not well suited for cooling and that costs are prohibitive for the vast majority of home owners—it is little wonder that cooling as a function of air conditioning is being played down commercially. While it is making the best of irrefutable fact, there is the physiological angle to give a certain validity to the new concept.

PERSONS who patronize theaters and other public places must have noticed, if they are observant, that temperatures are not as low today as they were when air conditioning was a novelty. This phenomenon results from the discovery that cooling for comfort must be relative and not absolute. Picking 70 degrees as a comfort point, regardless of outdoor temperatures, was comfortable only in theory and now we know that the maximum spread between indoor and outdoor temperatures should never exceed 15 degrees; that comfort is obtained within a zone and not at an arbitrary point, and that the zone fluctuates.

Coincident with this discovery of the gulf between the theoretical and the actual, experiments revealed that we really know very little about the body's air needs. Excessive cooling certainly seems to be worse than none at all. But it is known now that a considerable increase in comfort can be had by merely filtering, controlling the water content, and circulating air in enclosed spaces.

The realization that comfort rather than cooling *per se* is the objective seems a trivial one but it is vastly significant because it has enormously increased the desirability, possible scope, and use of air conditioning. If it is a departure from accepted definitions of what air conditioning should be, and only transitional, it has at least done this much—it has opened the way to make old residences more comfortable without excessive expense, it has brought relative comfort within the range of a larger public, and it has given the air conditioning industry something to go on while it works out the problem of designing full air conditioning equipment within a practical cost range.



Cut-away section of unit shown above illustrating the filter and humidifier

There are on the market today a great number of air conditioning devices. The simplest ones should be called "comfort makers" since they fall short of our air conditioning definition. Nevertheless, they belong in the discussion.

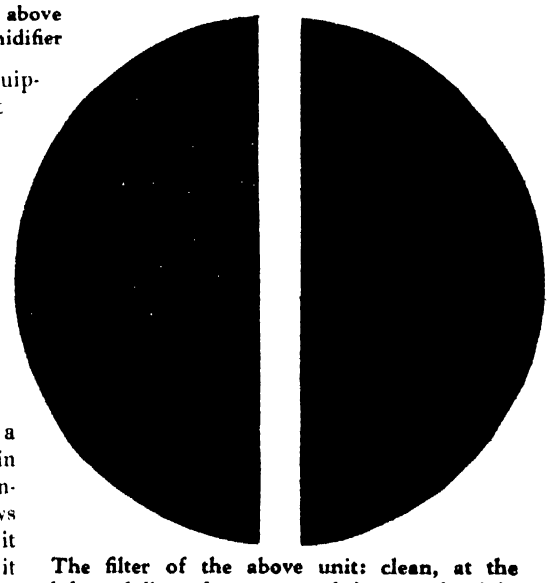
Probably the simplest device among many comprises a box-like structure which sets in the window much as does a ventilator. An enclosed fan draws air from outdoors, passes it through a filter and forces it through louvres into the room. There is no attempt at control of water content or temperature and the comfort contributed is solely one of providing a circulation of clean air which will help the body to rid itself of moisture. Such a device may also combine a silencing mechanism to shut out street noises.

Closely allied in type to the air circulator is a blower device designed to improve conditions in an entire house. It is nothing more nor less than a fan installed in the attic of a home, which draws air from below and expels it outdoors to create a steady circulation of air throughout the house. It is intended to prevent the accumulation of hot air in the attic during the day, while the circulation of the cooler night air tends to lower the temperature of the structure as well as its interior air with some lasting benefit during the day. In effect it does lower temperatures and helps to equalize them.

Approaching the definition of true conditioning there are devices for conditioning individual rooms. One type does a winter job of heating, filtering, humidifying, and circulating air, while a more elaborate type includes the features of cooling and drying to meet summer and year around requirements. These devices approximate an enclosed radiator in size and appearance and are operated by electricity.

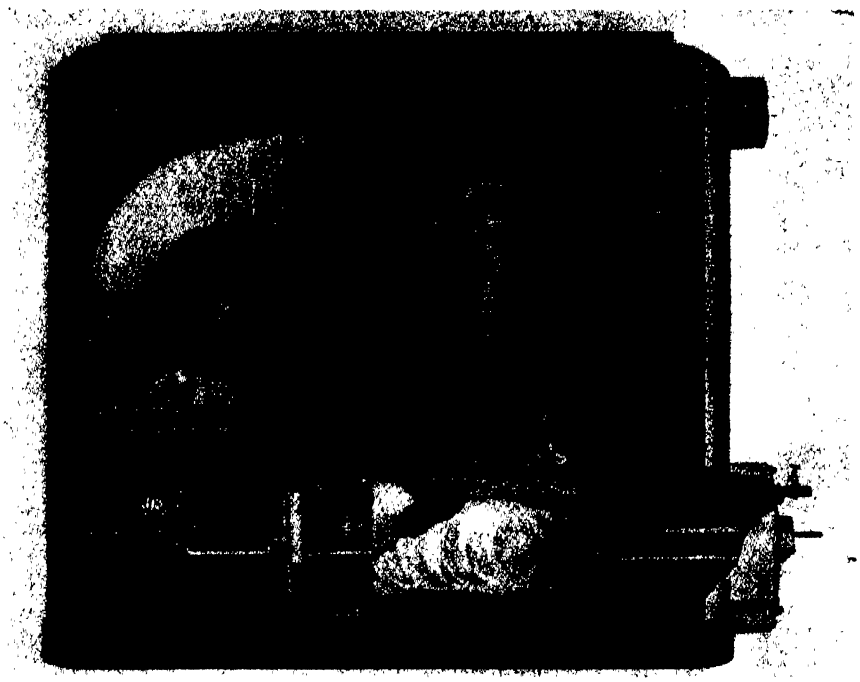
Also on the market are portable units, one type of which resembles a mechanical refrigerator, and functions in similar manner; another uses ice for the cooling.

Leaving behind the partial conditioners and single room units, there is equipment which is designed to handle the conditioning of an entire house. We find here a similar cleavage between cooling and non-cooling equipment with major emphasis placed on the other functions of conditioning. Indeed, the significance of cooling today is made plain by the absence of reference to it except in the most casual way, whether it be in sales literature or in announcements of devices about to be launched commercially.



The filter of the above unit: clean, at the left, and dirty after two months' use, at the right

The job of cooling an entire house is not one that air conditioners like to handle unless consumer funds are large. Installation and operating costs are a



Hot air heating—conditioned—is coming back! In this furnace unit, incoming air passes through filter, fan, and then over 36 linear feet of heating surface

sales deterrent. We all know something of the problem of mechanical refrigeration and its cost, so the refrigerator will illustrate the point. A typical refrigerator contains about eight cubic feet of space to be cooled, while a room 15 by 15 by 9 feet contains 2000 cubic feet. To make the latter comfortable with a drop of 15 degrees in temperature would require the equivalent of melting about one half ton of ice every 12 hours, and the current necessary to produce this amount of refrigeration is considerable.

THE use of ice as a cooling medium goes back many, many years. Weber and Fields once played at a New York theater where, for public attention, they competed with cakes of ice over which fans played to send forth a sort of arctic fog. From this crude device, development has led to equipment which uses the water of the melted ice, flowing through coils, as the cooling agent for the air which is passed over them. A number of ice installations have been made in private homes and presumably more of them would be seen if the ice industry were as aggressive as its competitors. Equipment for ice-cooled air conditioning is less expensive and simpler than the mechanical compressor type, but ice is more expensive than electrical current; hence, when equipment and power costs are considered together, ice is an economy only when operating time is short. It is best suited, for example, where large numbers of people gather, but where the period of use is too short to justify tying up large amounts of capital in equipment.

Air conditioning equipment manufacturers are in disagreement as to the desirability of making heating and air conditioning a single unit. Those who advocate a separation of the two base their contention on the fact that home owners may wish heating without conditioning and vice versa; and that division simplifies the problem of controls. Proponents of union declare that combining the functions makes for greater efficiency and simplification of equipment. Time alone will determine which camp wins. The governing factor at the moment is very largely the commercial one of expanding the type of business from which our manufacturers are projecting air conditioning. Merit in consumers' hands will settle the ultimate type.

Since conditioning involves air, it is no wonder that warm air heating has come back into vogue with the newest of designs, but this development by no means excludes other systems. Both hot water and steam heating systems can have air conditioning either as equipment for new houses or for modernizing old ones. Adaptation to both systems has been successfully achieved by using air conditioning on the ground floor and heating radiators on the floors above. The heating, therefore, remains the same, but the conditioned air is slightly warmed as well.

IN warm air heating systems the heated air is also the conditioned air, because functions are performed by a single unit. These are known as the direct fire type because the air comes into direct contact with the heating unit. In appearance the devices differ little from the modern oil- or gas-fired boiler, being both compact and automatic in operation. If cooling in such mechanisms is desired it must be had as a separate piece of equipment.

Although air conditioning apparatus varies greatly in design, there is a striking similarity in fundamental operation. Air is drawn from outdoors by fan or blower; it is filtered, humidified or dried, warmed or cooled, and discharged into living quarters through some form of duct. The most common type of filter comprises a two-inch pad of hair-like material saturated with oil to trap the dirt particles. There is also one of corrugated design which forces the air to turn a corner and pass over a sticky substance. Another type is constructed of minute glass strands laid criss-cross and graduated in mesh so that large particles are caught first. One conditioner is equipped with a signalling device to announce when the filter has become clogged beyond use. It sounds complex, but is really very simple. When the filter becomes choked, the air flow is reduced and the resulting change in pressure is utilized to raise a signal so that a new filter can be slipped into place.

A humidifier may be a simple evaporating pan located in the furnace; it may be an air washer or spray through which the air passes; in the case of warm air systems, it can be a steam vaporizer. Proper operation demands that it be capable of humidifying a given amount of air in a specified time, predetermined by the volume of the space to be conditioned and the amount of air to be circulated through it. Full comfort is impossible unless the proper humidity is established. The converse process, de-humidifying, is an accompaniment of cooling and follows naturally from the precipitation of moisture from the air as it becomes cooler; drying the air with coils is also practiced.

THE problem of circulating air is mainly one of seeing that a sufficient volume of air is handled to provide repeated changes in rapid succession; that this air enters and leaves the room through ducts in such manner as to provide movement in all parts of the room; and to do this without drafts or undue noise.

Air conditioning is very simple, but actually very complex when carried out on a commercial scale. We have already pointed out that construction is of prime importance because air cannot be controlled in a structure which is a sieve. Then there is the factor of dwelling design which makes every installation unique if it is to function with maximum efficiency. The floor layout affects the air volume required, rate of air flow, and positioning of ducts. The number of persons to use a room and their activities also influence the solution.

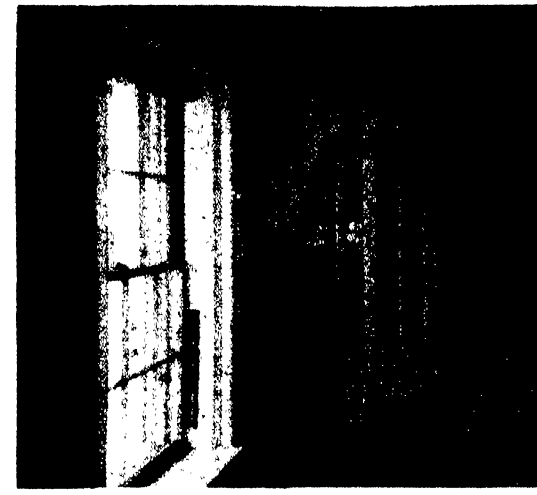
Individuality of structures, which makes for specialization in equipment,

retards the standardization of equipment and hence delays a mass production which would lead to a lowering of cost. Until the engineering is standardized to a much greater degree there can be no mass market, or mass installation, not alone because of high initial cost but because of the skill required to install with satisfaction.

The progress of the past few years has been in the direction of this requisite standardization. Conditioners have been simplified, made more positive and automatic in action, more efficient in operation. Ducts have been designed so that there is less hand shaping and cutting required on the site. Requirements for comfort have been worked out so that what is needed can be told in advance and the consumer is assured of getting the service that he seeks. But this still leaves the problem of cooling very much as it was before.

The fact that cooling is subordinate for the moment does not imply that it will be so always. Cooling is a major part of comfort needs: it is the function of air conditioning which the public is most consciously wanting, and that alone is reason enough for further research and development to obtain it at reasonable cost. De-humidification, which is needed for conditioning in summer, is being tackled along different lines already, the new angle being the use of moisture-absorbing chemicals through which the air can be circulated, but actual cooling may have to find its ultimate solution along lines not yet contemplated.

A hint of developments yet in store is given by one enterprise now entering the commercial stage. It involves a new conception of house construction, but steers clear of the windowless tomb of which we have heard so much already. This house is built of steel, brick, and cement and is thoroughly insulated with cork, but its unique quality arises from the manner in which these materials are assembled. This will be described best by tracing through the air conditioning plan.

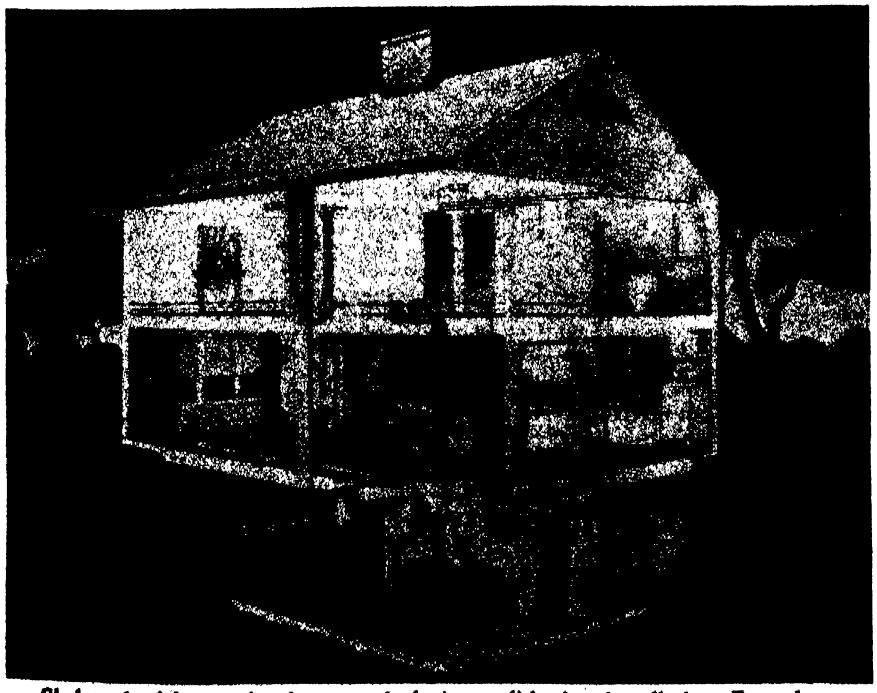


During the summer, the slot beside the lower sash of window of "The House That Breathes" is the air inlet while the outlet is a grille high up on the wall of the room. In winter, the direction of air flow is reversed

Air enters under the eaves and passes down through a section of the hollow wall—lined inside with cork, on the outside with a brick veneer—to a duct which conveys it to a warm air furnace. Having been filtered, warmed, and humidified, the air is forced up through ducts and injected into the room through a grille near the ceiling, and then returned to the basement through slits in the window casing which permit it to fill the remaining hollow wall areas on its way. Upon reaching the basement, the air is expelled through a chimney, not to be reconditioned. Exhausting the warm air through the walls in winter time is claimed to aid in maintaining an even distribution of heat.

In summer, the process is reversed by shutting a damper. Air is drawn from outdoors at the foundation level. This entrance is nothing more or less than a cellar window of double construction with the air passing between sashes. The air passes through the hollow walls where the brick surface tends to de-hydrate it and cool it (a temperature drop of about 12 degrees is claimed). It enters the room through the window frame slits, exhausts through the wall grille and is again dispersed through a flue in the chimney. Because the heating system is of the warm air type and air is drawn from outdoors with a natural conditioning process, the only necessary extra equipment is a blower. In summer even the blower may be shut down because of the natural air circulation through the house.

This particular solution to the air conditioning problem involves construction with conditioning in mind and it is probable that most other solutions will place heavy emphasis upon the fundamental building design. Certainly, it moves in the right direction for it answers the problem of cost which now stands squarely across the path of further development. It also regards heating, insulating, and air conditioning as unified problems and there are many authorities who believe that there can be no final solution which is not so based.



Skelstonized house showing a typical air conditioning installation. From basement units, fully conditioned air is distributed through ducts, summer and winter

WE can't get away from it. Satisfactory air conditioning is inseparably linked with insulating and heating, two factors which are as yet in a primitive stage of development. Their joint study and joint solution are called for, and when this has been achieved the home owner will perhaps save enough on fuel costs to get his air conditioning as "velvet."

Photographs courtesy American Radiator and Standard Sanitary Corp., Borg-Warner Corp., General Electric Co., and The House That Breathes, Inc.

MISINTERPRETED

Things which Have Been Considered Detriments in Protective Coloration are Actually Protective in the Highest Sense—to the Helpless Young

THE long-discussed evidences of natural selection, combined with De Vries' mutation and supposedly in contradiction to the practically inapplicable Mendelian heredity, have so confused many natural scientists that some of the compelling influences which govern development appear to have received too scant attention. At least small mention is made of certain striking influences that bear directly upon the evolved characteristics of protective coloration apart from resemblances to surroundings. Not until very recent years, if at all within the minds of many observers, have these well-proved features been understood or accepted. Even so, there will be, as always, dissent from new discoveries, no matter how fully convincing the evidence.

My friend the hunter-naturalist sees Molly Cottontail leap away through the grass and, were it not for the flash of her white fluff glaringly disclosing her rapid retreat, the shot that laid her low would not have been so unerringly directed. Hasty comments follow: There are many white-tailed creatures that thus signal their presence to their enemies and that might otherwise escape notice; can it be that natural selection, commonly unerring for the perpetuation of species, would so reverse its influence? Doubt of the entire process often results.

THE long-held theory that these features serve as signals to others of their kind, or as recognition marks, would seem by observation to be impractical. Metcalf in his admirable, non-technical "Outline of Organic Evolution" says: "Birds and mammals especially display these" (recognition signals). He cites the common rabbit, the white-tailed deer, the western antelope, and African gazelles with similar white rump patches, and he quotes Alfred Russell Wallace as interpreting that "the white outer tail feathers of birds and the streaks and spots about the head are recognition marks by which the individuals of the same species identify one another." Metcalf adds: "Probably this is a true explanation of one use of such marks," and he quotes C. Hart Merriam's suggestion that the white colors mainly conspicuous upon certain insects, birds, and mammals when in motion are but to give a confusing comparison to the obliteration of these markings when the creatures alight or crouch, thus giving the effect of a sudden disappearance.

Surely the theorists have been hard put to it for an explanation of features that for a long time were most completely misunderstood and also misinterpreted through lack of knowledge and comprehension. If characteristics showed in any way an actual disadvantage instead of protection there could not be a selective influence, and to that the immutability advocates heartily agree, taking a great number of willing sheep with them over the fence into barren pastures and some of the overestimated philosophers and nature students too eagerly joined the flock. Leading the van, a great nature writer pronounces Darwin completely repudiated—a rather pitiful position when the facts are displayed.

But how can the objectors be other than right? With hardly an exception those beasts and birds that are commonly preyed upon by terrestrial predatory animals, and are the least able to defend themselves or their young, are in some way especially attractive to

Molly Cottontail flashes her signal and hungry Reynard does not stop to discover the young bunnies hard by. It is the instinct of the predatory animal, like some human beings, to take after the meal that attracts its most immediate attention

Animal Observations

By S. F. AARON
Illustrations by the author

their enemies. All the world's deer, antelope, and gazelles, all the darker colored goats and sheep, have great white patches on their rumps, displaying thus their get-away to pursuing enemies and to man; the rabbits and hares flash their white flags against the dark backgrounds of brown fur and herbage as signals to foxes, wolves, the cat tribe, the minks, and weasels. And there are the very numerous ground-nesting birds and some others, with flaring white tails to flaunt before hawks, owls, and many leaping, four-footed enemies. Has selective protection overlooked this apparent reverse to that which has been so universally claimed for it?

HOW simple and easy is the answer when we know the facts, substantiating rather than refuting the great law of development. It is dangerous to accept hastily a principle until all the facts are fully known and digested.

There is one period in the life of every preyed-upon creature when it is subject to far greater dangers than can assail it later. This, of course, is during extreme infancy when both escape and defense are impossible. But behold parental care: the development not only of mother love, but of physical characteristics widely distributed that, instead of endangering the races of creatures that possess them, commonly insure safety for the helpless young.

A hungry cat's nostrils are filled with a most delectable odor: rabbit—young, tender, hard by within a wide patch of long grass. Crouching, she begins a smell-directed hunt that in a moment must disclose the warren, deep set in the ground, containing six or eight helpless, half-naked little things that may easily be clawed out and dined upon. So sure is the eager huntress of a meal, following her unerring nose alone, she is about to leap into the midst of the grass when suddenly a form takes shape before her that a moment ago her round, staring yellow eyes could not discern and Molly Cottontail, on the alert to protect her young, leaps up and slowly away among the grass, her ground color not distinct, but the pure white bunch of a tail glaringly so, unmistakably alluring. Without hesitation the killer goes after the signal, leaping, but always a little short of the mark until the warren is left far behind and the cat finds herself no match in speed for the owner of that deceptive white flag.

The male scarlet tanager boldly flaunts his colors and the sharpshinned hawk is tempted to give chase. Thereby he is led far beyond chance of discovering the brooding mother bird

The crouching, powerful puma anticipates mountain lamb, but the big cat's approach to the little creature hardly able to use its legs is interrupted by the more desirable mother big horn who offers herself and her white rump patch as a greater inducement; the big cat, with long leaps, going after her, only to find the mother sheep's speed the greater; the saved lamb, no doubt, wondering what all the scratching of gravel is about.

At night the vesper sparrow, brooding her clutch beneath a towering tangle of weeds, is awakened by a jostling of the grass around her and stares into the eyes of that sneak thief, the skunk, who loves bird eggs and young birds better than anything else. But he has not seen the nest yet, and he does see a slow-moving spread of white feathers. After that he goes, keeping on until the white feathers disappear in swift flight, yards away from the nest.

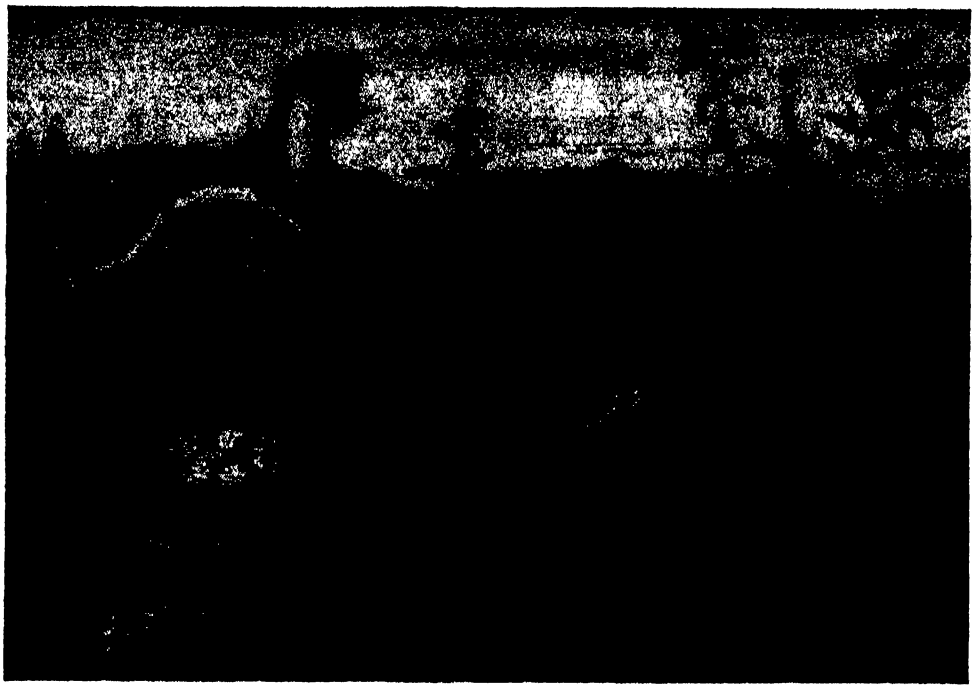
SO potent is this developed signaling to a foe for the protection of the helpless young, and so universal is it among the creatures that are easily approached by many enemies, that it is as constant in character and habit as any other dominant trait. Nature has fixed this necessary habit so firmly that at all times do fleeing deer and antelope hold their tails aloft, making the white the most visible object about them; the black-tailed deer of the American northwest shows only the white under surface of the tail when retreating. Every mother ungulate that is not able with horns backed by superior weight to defend her young, as can the bison, buffalo, musk ox, and moose, possesses the wide white rump patch, or the white tail.

As for the ground-nesting birds, much the same may be noted, and a list of those that are so endowed would be too long to print here. These will also include some that nest on large branches or in holes in trees that may easily be reached by predatory creatures: the mourning dove, the robin, the wood-

peckers, the shrikes, the cuckoos, certain wood warblers, the nuthatches and the chickadees are examples, and all of these birds practice alluring actions.

Rarely need the birds nesting in vines, bushes, or dense herbage, or upon the outer branches of trees, find use for such protection for their eggs and young, as their climbing enemies cannot follow their deceptions. Hence, with the exception of the kingbird, few of these have any white about them except the under parts, which are not seen when retreating.

Except in daytime (and most of the enemies of ground-nesting birds and of the nearly defenseless mammals hunt at night), no color but white, no matter how bright, can well serve the purpose as a camouflage. It must be noted, however, that white tails and rumps are not the only very visible parts of retreating mothers; the white patches of head, body, and wings serve a similar purpose. The head markings of the white-throated and white-crowned sparrows are examples; the ducks, snipes, sandpipers, and plovers show many white patches that serve. It is only necessary to observe the remarkable antics of the kildeer in holding its white-patched wing aloft when its nest is approached, to be convinced of the value of these characteristics.



The white tail of the meadow lark draws the weasel away from the nest. Similarly mourning doves, robins, woodpeckers, shrikes, cuckoos and other birds carry flashy signals

WE also find exceptions to this protective coloration of tails, or other displayed parts, among ground-nesting birds. In every such example there are counter-causes and it must be borne in mind that development influenced by one certain cause may result in varying characteristics. Thus many of the sparrows and warblers, the brown thrasher, the veery and the hermit thrush and some others possess sufficiently bright colors, other than white, for attraction during the daytime. But all these species show other characteristics that may be as effective in saving the young as the commoner influence noted. It will be observed that loud notes of warning are uttered, with much excited fluttering about, close to the interloper.

Again it will be seen that, when many birds, especially among the bush and ground-nesting sparrows, are flushed from the nest they retreat a little distance, often the shortest to be safe, and invariably turn toward the intruder, exhibiting their white breasts. This may be the function of the white under parts of most birds, for what other purpose could such an almost universal feature serve?

In his "African Game Trails" Colonel Roosevelt clearly shows that among the hunted and some hunting creatures there is little truth in the idea of protective coloration to adult animals, and this finds substantiation everywhere from giraffe and zebra to the tiniest deer. Rather does the coloration of most species, as the observing naturalist proved, call ready attention to the many creatures in question.

But the value to these animals of their advertisement to their enemies is missed entirely and it must not be overlooked that the adults can depend upon their legs.

Nothing has challenged speculative evolution more than secondary sexual variation: the relative unessential differences between the sexes of highly organized creatures. Primary sexual development deals with the essential differences for purposes of propagation. Those that are non-essential have been termed secondary. Examples are the mane of the lion, the antlers of the stag, the horns of the billy goat, the plumes and brilliant colors of male birds.

Very naturally within our scope of better understanding come our feathered friends of garden, field, and grove. May I say, though with profound respect for those observers who have elucidated so much of value, that it is difficult to understand how the many biographers of avian life have failed to grasp certain salient facts. The greatest, most widely learned of all naturalists, in his eagerness to find an explanation for the secondary sexual differences in many birds, overstepped the bounds of possible animal intelligence when he ascribed to the females of the species an esthetic sense, an appreciation of the beautiful. Birds do contemplate nesting-sites and show wise selection of nesting materials, and they undoubtedly reason on ways and means and the overcoming of unforeseen handicaps, but there is very little reason to suppose that most of them at least are more attracted by what seems to us beautiful than that which appears to the human mind as dull. To quote:

"It appears that female birds . . . have by a long selection of the more attractive males added to their beauty or other attractive qualities," and farther on: "No doubt this implies powers of discrimination which will appear extremely improbable . . . but I hope to show that the females actually have that power." ("Descent of Man," Chapter VII.)

THIS idea of conscious and intentional selection fixed thus in the minds of observers who follow the lead of the learned promulgator of a dominant law, has simply been accepted and has persisted for over half a century without contradiction and to this day is confidently advanced. As an example, in a recent number of a popular periodical a worthy nature student charmingly sets forth the same idea. Professor Henry Smith Williams says: "We can explain the dangerously conspicuous costumes worn by many summer birds only on the ground that the females of the species love bright colors and persistently discriminate in favor of the males that are the most vividly adorned. . . . This may even jeopardize the race, but the esthetic eye must be served." He goes on to speak of "dangerous dandyism" as a possible cause of extinction.

And again, concerning sparrows: "They have been content to choose plain-coated husbands. No spectacular mates to advertise the location of their nests and menace the entire family by signaling their presence to enemies."

Now then, let us look at this really simple matter of selective development as it deserves, after a somewhat more careful observation; whereupon we may entirely deny the foregoing acceptance of purposeful selection.

In the first place, female birds do not select the more ornate or colorful males as the most attractive. Instances among domestic fowl abundantly prove this fact, and there is not wanting similar evidence concerning the wild creatures.

WHEN orchard orioles first return in the spring from the South the young males are olive green and dull yellow, much like the females, and their songs are generally inferior to the brighter-hued members of their sex; yet a lone female will often take up with these youngsters in preference to the black and red males of an earlier season. I have known two instances of this, and one where a goldfinch, mating unusually early, accepted as a husband a fellow no less proud, but which had not yet received his sulphurous adornments. I knew a jaybird that turned down one uniformed suitor for another without a tail, a cat having deprived the latter of his elegant possession.

Hens frequently accept only the attention of dull-colored roosters rather than of those bedecked with bright colors. Pigeons in mixed lots do the same, and fanciers well know this. Ducks, whether polygamous or singly mated, are absolutely indifferent to colorful beauty as man appreciates it.

Consider also the influence of voice and its sexual selection. Birds do not sing in a musical sense. In no instance, asking the pardon of the poets, do they mean to charm the female, nor is she the least affected. Just as chanticleer utters his challenge to all possible rivals, as the turkey gobbles or the grouse drums, so the birds sing. Even the sublime hermit thrush, the masterful mocking-bird, the softly cadencing field sparrow, the chanting cardinal, utter their so-called song notes as a defiance to whatever rivals may dare to invade their chosen precincts. This fact is beyond contradiction, as shown by numerous instances. At no time will a cardinal, a Baltimore oriole, a Carolina wren, a horned lark, nor a veery pour forth sweeter and more voluble notes than when engaged in actual combat with another male of the same species. Few, if any, birds sing around the nest or when courting. Mate two canaries and the male rarely sings; separate them and almost any harsh sounds excite his ire and start his trills. Throw a stone into a bush and the chat or the yellow-throat, like the English nightingale, not lacking imaginative suspicions, will at once pipe up to defy a supposed rival.

Much the same influence governs strutting, dancing and cutting capers as practiced by grouse, true pheasants, many water birds and grackles. The turkey tom struts and gobbles only when he wants to convince himself that he is monarch of all he surveys, never when he is importuning some coy hen.

What, then, has been the process of selection to bring about the bright adornments of many male birds? So distinctly in evidence is it that it must play an important part in the survival of many species, not their destruction, and it is indeed remarkable that its influence was not comprehended when the differences in plumage between the sexes was noted. For how very simple it is and how easily it may be interpreted.

Burroughs wrote that the best way to make intimate observation is to go into the woods and fields and remain quiet, as does the squirrel hunter. Who among us has not profited by that advice? At least the facts here set forth owe their discovery to its practice.

The female tanager is up there on her nest in "the heart of the ancient wood" and it will demand the eyes of a hawk to discern her green back within her bower of leaves. But a rapacious bandit appears suddenly, seeking the eggs or young birds, or, better, a well-fed adult. A little searching will surely disclose the nest and the mother bird. What, then, will suffice to protect them? Nothing more than the most effective appearance of the black and scarlet male at a little distance, flashing his gorgeous hues in direct defiance of the robber.

IMMEDIATELY the hawk goes after him, but he dashes away to thick cover and the would-be murderer is led afar, the brood saved.

But should the hawk capture the male the latter can be better spared in the process of perpetuation than the female or the young. Had the scarlet and black been replaced by olive-green would the enemy have been as quick to see and to follow the male?

I have witnessed, though but once, this very act and it required no great wit to interpret that which should have appeared conclusive long before, from seeing not quite fully enacted similar and suggestive behavior on the part of other species. I have watched a cat sneaking in the weeds and grass near a bobolink's cradle; whereupon the male bird eagerly displayed himself, undoubtedly to lure the cat away, which effort was accomplished.

Thus it is with the oriole, the goldfinch, the indigo bird, the Kentucky warbler, the cardinal and many others—approach the nest and you at once become aware of the near antics of the male to attract your attention. Remarkably is it true of the red-winged blackbird and of the rose-breasted grosbeak; the latter presents from a near limb his white and red-blotched breast in contrast to his inky black, and only the wisdom of man sees through the scheme; the hawk or day-hunting owl never can.

Thus the bright plumage of many male birds, instead of being a product of selective vanity and resulting from an estheticism altogether impossible, is really the result of a very evident need; and instead of being "a dangerous dandyism" is a distinct protection to the species and a large factor in its perpetuation. Far from advertising the nest, it provides a counter-lure to guarantee safety, as does also the pretense of injury practiced by many mother birds.

The puma goes after the mother big-horn's white rump patch. She draws the big cat on for half a mile or so and the lamb is safe. "Protective" coloration?

RECENT PROGRESS IN

What Actually Causes Earthquakes? . . . How Deep Do They Originate? . . . Is The Earth's Core a Solid or a Liquid? . . . The More We Learn the Less We Know!

WHEN a baby first learns to walk, it likes to look back from time to time to see how far it has traveled. Seismology is still taking baby steps and, in this article, I propose to look back and see how far we have traveled seismologically in the last few years.

In the matter of instrumental development, the most recent progress has been the perfecting of a new instrument especially adapted to the detection of local earthquakes. These local earthquakes are known to have an extremely short period. In contrast to the last short period instrument developed some ten years ago—the Wood-Anderson torsion pendulum with a mass of one fortieth of an ounce, shown in Figure 1—the new Benioff instrument shown in the same figure has a mass of three-quarters of a ton and the extremely short period of one half a second. An idea of the sensitivity of the instrument can be had when we say that a ground motion of one two-millionth of a pinhead is easily discerned on the galvanometer. The magnification for extremely short period waves is of the order of 100,000.

Since the invention of this instrument, hundreds of local quakes are recorded annually that would otherwise pass unnoticed. But, though so admirably adapted to the recording of local quakes, its use is by no means confined to local disturbances. It has the added feature that it can be coupled to a long and short period galvanometer simultaneously, making it a two-in-one instrument for recording both local and distant quakes. The acquisition of this new detective to its staff makes seismology a veritable Scotland Yard. It will be hard for an earthquake to escape detection now.

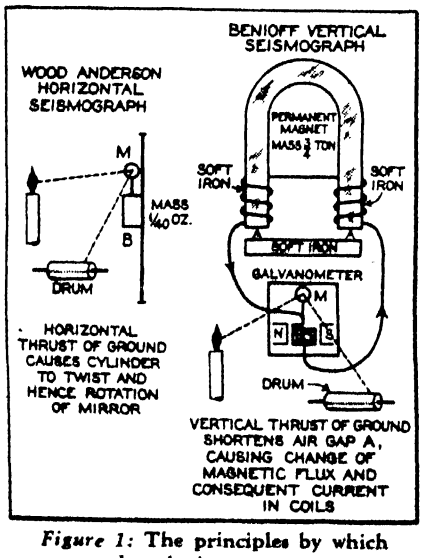


Figure 1: **The principles by which two earthquake instruments operate**

TURNING from the instrument to the records it produces, one type of record that has long puzzled seismologists is the record of micro-seisms (Figure 2). These micro-seisms are small vibrations with a period of a few seconds and a ground movement of about one three-hundredth of a pinhead, that continue periodically for several days at a time. They occur whenever we have a severe windstorm or whenever we have a sudden cold spell, and they are slight up and down motions of the ground extending down some depth and felt simultaneously over wide continental areas. Extensive investigations have been carried on to determine the cause of these baby quakes and, to date, three explanations have been offered. One explanation is that they are caused by the beating of the surf against rocky coasts. A second explanation is that the ocean imparts a vibratory motion to its bed which, in turn, imparts it to the entire continent. A third explanation is that they are vibrations caused directly in the continent by barometric changes above it. The majority of seismologists seem inclined to favor the latter.

Another question which the seismograph record is expected to answer is: "What is the nature of the core of the earth; is it solid or liquid?" One of the waves started by an earthquake is what is known as a shear wave which can travel only through a solid. Does this shear wave travel through the core of the earth? If it does, the earth is a solid. If it does not, the earth is a liquid. To date, there has been much dispute as to whether or not this shear wave has been proved to have passed through the core. Seismologists have looked for it on their records but it is not easy to recognize, since it always occurs, if it

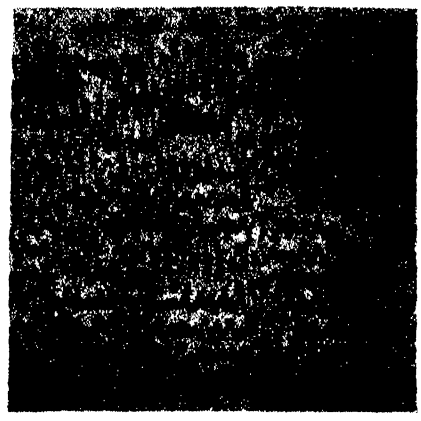


Figure 2: **Typical micro-seisms. What causes them remains a puzzle**

occurs at all, in the midst of a group of other reflected and refracted waves, many of which are stronger than itself. Seismologists in Japan, in America and elsewhere, claim to have positively identified this core shear wave on their records, but there are still some authorities who doubt their findings. The consensus seems to be that the shear wave does pass through the core and, hence, that the earth's core is solid. However, the decision to date is not quite unanimous.

Perhaps the most interesting topic discussed by seismologists recently is the depth below the surface at which an earthquake occurs. It was previously thought that earthquakes occurred comparatively near the surface—within a depth of about ten miles. In recent years, it has become apparent that earthquakes occur at much greater depths than this. We have reason to believe that they can occur at a depth of 500 miles. The first thing that led seismologists to suspect so great a depth for the origin of an occasional quake was their inability to locate some quakes. With plenty of perfectly good records obtained from well-equipped stations, occasionally it was impossible to locate the quake in a position which would satisfy the distances demanded by the records of the various stations. As an extreme case, a well-equipped station was occasionally found to place a quake as much as 400 or 500 miles away from the true location. This error I refer to was one of estimated distance—not of direction. (There is often an uncertainty of direction but rarely one of distance.)

Now the tables by which the distance of a quake is read off from the time difference between the arrival of the

EARTHQUAKE SCIENCE

By REV. JOSEPH LYNCH, S.J.
Director of the Seismic Observatory, Fordham University

longitudinal and transverse waves of a record were computed on the supposition that the quake occurred near the surface. The tables would be in considerable error if the quake occurred 500 miles down. It was suggested that these occasional errors of distances on the part of reliable stations were due

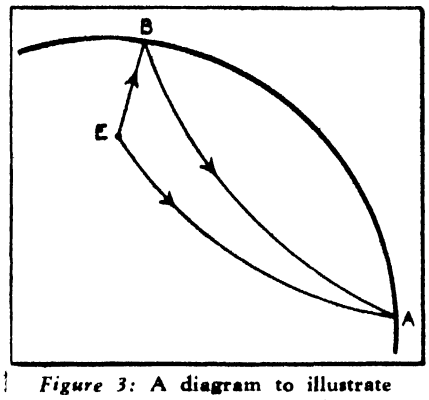


Figure 3: **A diagram to illustrate the argument outlined in the text**

to errors in the tables—or rather, due to the fact that the tables could not be used for such unusual depths of focus. For some such rebellious quakes, new values were computed for various depths of focus, and it was found that the supposition of a suitable depth of focus enabled the readings of the various stations to be brought into agreement and the quake to be definitely located.

Let us suppose now that a quake occurs at an unusual depth below the surface, at *E* in Figure 3. One wave should travel directly from the quake to the observatory at *A*. Another wave, starting out with the first from *E*, should travel up to the surface at *B* and from *B* down to *A*. It would arrive at *A* a little later than the first. Such a pair of waves were looked for in rebellious quakes, suspected of being at deep focus—and were found.

Suppose now, as in Figure 4, the observatory *A* were at the end of a diameter passing through the quake. Consider the two waves at *A*—the wave traveling directly from *E* and the wave going first from *E* to *B* and then from *B* to *A*. The time difference between these two waves is simply the time an earthquake wave takes to travel twice the distance from *E* to *B*, and hence the distance *EB* is known, since we know how fast an earthquake wave travels in the crust. *EB* is the depth of the quake below the surface, or the depth of focus. The wave traveling directly from *E* is called the *P* wave or "push" wave. The wave traveling from *E* to the surface and then to the station is called the *pP* wave, to distinguish it from the former. Tables have now been computed for the depth of focus corresponding to all possible time intervals between these two waves—the *P* wave and the *pP* wave—so that the seismologist is now able to determine not only the distance of the quake but also its depth of focus. In this way it has been found that many quakes have their origin at a depth of 500 miles or so beneath the earth's surface.

This discovery has brought up a further difficulty. An earthquake has usually been considered a fracture in the earth's crust. Is it possible for a fracture to occur at such a depth? The depth of the crystalline crust in which fractures might take place has been variously estimated from ten to 30 or 40 miles, below which is the supposed region of flow. By flow we do not mean that this glassy region is liquid—but that it admits of isostatic compensation or adjustment to varying loads above. A depth of 500 miles would seem, therefore, to be in a region where fractures do not occur.

TWO possible viewpoints arise, then, for these deep-seated quakes. (1) They are caused by fractures—but fractures occur at much greater depths than was formerly thought possible. (2) They are not caused by fractures at all but by some other cause. What is the other cause? A suggested cause is taken from thermodynamics. Quite recently it has been found that, at enormous pressure and only moderately high temperature, a change of state occurs in some substances with explosive violence. In the light of these experiments it has been suggested that a deep focus earthquake is the explosion resulting from such a change of state under the enormous pressure that exists hundreds of miles below the earth's surface. The matter has not been sufficiently discussed as yet to enable one to give the consensus among the seismologists.

In recent writings, both the fracture and the thermodynamical origin of earthquakes have been advocated. The weight of evidence from seismology seems to favor the fracture origin of earthquakes. Briefly, this evidence is: (1) In some deep focus quakes, the bulk of the energy is in the shear waves—not the compressional or explosive waves which one would expect, were the earthquake an explosion. (2) At the same location or epicenter we have both deep and shallow focus earthquakes occurring (at different times, of course). Since the shallow focus quakes are caused by fracture, it seems reasonable to attribute those of deeper focus from the same epicenter to the same cause. (3) Deep focus earthquakes so far have not been found off the beaten track of earthquakes—they occur only in definite earthquake regions. They would seem, therefore, to be brought about by the causes of earthquakes in general.

If the thermodynamics explanation were correct, one would expect an occasional thermodynamic explosion somewhere off the beaten track of earthquakes. Yet in a period of 20 years or so, no deep focus quake has occurred very far from the equator or outside the Pacific Basin, the usual home of earthquakes but perhaps after all, we now know far less than we did of the origin of earthquakes because we now know so much more—which reminds one of the popular glee club number:

The more we study the more we learn,
The more we learn the more we forget,
The more we forget the less we know,
So why study?

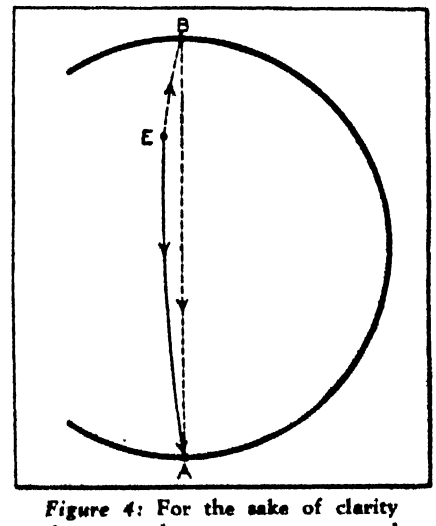


Figure 4: **For the sake of clarity the two paths were not superposed**

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER

Chemical Engineer

A Steam-Driven Elephant

NO; to the contrary, foundrymen did not get facetious and attempt to mold an elephant, though the accompanying illustration may give that impression. Despite its resemblance to an elephant or

An "elephant" born in a foundry

some beast that roamed the earth in prehistoric time, the "monster" is in reality only the outer high-pressure shell casting of a steam turbine. The photograph was snapped in the General Electric works immediately after the casting was removed from the mold—before the cleaning, trimming, and machining operations necessary to make it a part of a powerful turbo-generator set had been performed. The turbine will be a 40,000-kilowatt unit when completed.

Selenium in Wheat

SELENIUM, the chemical element used in some light-sensitive cells, is absorbed from soil containing it by wheat grown on seleniferous fields. Not only is selenium absorbed by wheat and concentrated in the grain itself, but it is an active poison, according to W. O. Robinson, of the Bureau of Chemistry and Soils. The danger from this source can be avoided by careful examination of imported wheat since there are few areas in the United States where selenium occurs in the soil in quantities offering a hazard and these are already carefully mapped. There is, however, an added danger in the import of wheat from unknown areas which may contain selenium.—*D.H.K.*

BRITAIN'S MOTOR FUEL

NO less than 15 methods of carbonizing mixtures of coal and heavy oil to yield motor fuel have been practiced in Great Britain within the past six years.

Scratch May Produce Shock or Death

SCRATCH allergy has been added to the list of conditions of hypersensitivity, Dr. Williams W. Duke of Kansas City reported to the American Medical Association, according to *Science Service*.

Besides persons who are sensitive to pollen, such as hay fever sufferers, and those sensitive to foods, heat, cold, and effort, Dr. Duke has now discovered patients who are so sensitive to mechanical irritation that a slight scratch may cause them to develop any reaction from hives to shock and possibly sudden death.

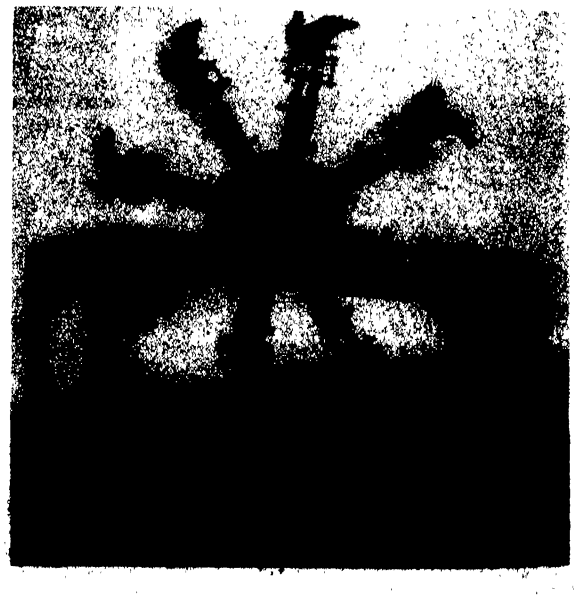
Such individuals can be desensitized, Dr. Duke reported, by scratching themselves thoroughly each morning and evening with a stiff hair brush or bath brush. Similar treatment by small exposure to the causative agent, whether heat, light, cold, or effort, will "cure" the hypersensitivity in the other patients.

"Rubber" to New Guinea

FOR the first time in history, a synthetic rubber has invaded a natural rubber-producing country to perform a function which the natural product cannot perform. Unlike "sending coals to Newcastle," the shipment of synthetic rubber to New Guinea, in the South Seas, was an actual necessity in this case.

This synthetic rubber is DuPrene. It goes to New Guinea in the form of an outer jacket for about 700 feet of heavy cable built by the General Cable Corporation, of Rome, New York. It is used as this outer jacket because natural rubber cannot stand

Simulating actual conditions of wear, the machine shown at the right was developed by the Bureau of Standards as an aid in preparing standards for shoemaking. The machine was designed at the request of the General Federation of Woman's Clubs. Motion pictures of people were studied in order to produce the proper foot action in the testing machine. The heel of the shoe first comes in contact with the moving belt, then the heel and sole both press on the surface. The load on the shoe gradually decreases as the belt moves along, the heel leaves the belt, and the toe is flexed as is done in walking. Courtesy *Industrial Standardization*



the devastating sun rays of the South Sea jungle, where it is being used.

The Bulolo Gold Dredging Company is mining gold far in the jungles of New Guinea—in fact, so far from civilization that there are no roads and no surface transportation facilities. Hence all of the machinery used in the gold producing operations, including the cable, was transported by airplane, and the refined gold is brought out in the same manner.

As can readily be imagined, the heat is excessive and the direct rays of the sun are so severe that natural rubber for a cable jacket was found to break down quickly and completely.

Better Caustic

CAUSTIC soda, the most important of the strong alkalies, is produced in crystalline, anhydrous form more economically than by the customary fusion process by a new method developed by Autoxygen, Inc. Not only is all the water economically removed from caustic by the new method, without resort to fusion at high temperature, but the product is exceptionally free from sodium chloride and carbonate and is in an especially active form.

The old method consisted in evaporating as much water from the solution of the alkali as possible and finally heating the concentrated solution in heavy iron pots to the temperature of fusion of the caustic. Its product is a solid mass which must be broken up for use and which contains more or less impurities in the form of salt and sodium carbonate. In the new process, the concentrated solution from the evaporators is sprayed into a hot organic liquid, such as kerosene, which boils away with the water from the solution and thus yields caustic soda in fine, pure crystals. In this form caustic is very highly reactive chemically and it is expected that its use will greatly facilitate many important synthetic processes. Among the important applications of caustic soda are the manufacture of soap and many other valuable compounds.—*D. H. K.*

New Steel Trailer

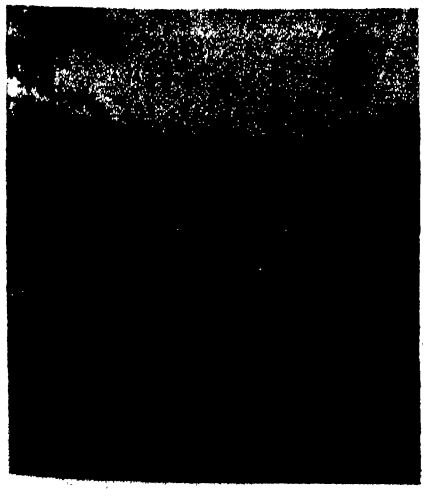
PRODUCTION of an all-steel, low cost, utility trailer for passenger cars by the Mullins Manufacturing Corporation was announced recently.

The trailer, which is of modern, streamlined design and will carry a maximum load of approximately 1200 pounds, is mounted on two standard automobile wheels and tires, and has the standard tread of 56½ inches.

Cutting nickel-cast-iron dies which form Hudson motor car tops is the job of the big Keller machine illustrated at the right by courtesy of *Nickel Cast Iron News*. The die-cutting machine first roughs out and then finishes the die, the cutting tool being guided in its path by the finger which passes over the master model shown above the die that is being cut. The corrugated surface of the die has only been rough cut, while the finishing operation is underway on the opposite end of the huge die

All-steel, with hinged cover and tail gate, the lines of the new trailer conform to those of the modern automobile. It has unusual features of design and construction which are expected to appeal to tourists, sportsmen, merchants, vendors, salesmen, and farmers.

The trailer weighs about 485 pounds and has an over-all length of eight feet. The body is 47 inches wide and 16½ inches high, although the extreme height of the body and lid is 29½ inches. The end gate is 19 inches long and 34 inches wide. The wheels are stamped steel and the unit is carried on an eye-beam axle. The tire size is 17 inches by 5.25 inches.



***Left:* A new pressed steel trailer for motor cars. *Above:* The trailer cover opened, showing how it may be fitted with two beds for camping**

Lalor Foundation for Scientific Research

ANNOUNCEMENT was made in May of the Lalor Foundation, a Delaware corporation, organized for the advancement of scientific research and the encouragement of the arts. The Foundation is the recipient of a bequest of 400,000 dollars from the late Willard A. Lalor, a retired official of the Chicago, Burlington & Quincy Railway and resident of Washington, D. C. This bequest is a testimonial to his sister, Mrs. Anna Lalor Burdick, of the United States Department of Education in Washington, D. C., and to his brother, John C. Lalor, who was prominently identified with the early development of the mining and metallurgical industry in Montana.

Awards for this coming academic year will comprise five professorship and fellowship grants of 2500 dollars each. These awards are designed to give recognition to mature scholars of demonstrated ability and to afford opportunity to these men and women to conduct advanced investigations of a purely scientific character in appropriate fields of knowledge and under the freest possible conditions. Recipients of the awards for the coming year will be made public shortly.

The announcement was made by Dr. C. Lalor Burdick, Secretary of the Foundation.

FARM OIL CROP

RECENT studies made by the American Petroleum Institute have disclosed that oil taken from beneath American farms provides income of approximately 200,000,000 dollars annually for American farmers.

Adhesive Plaster Solvent

THE difficulty of removing large pieces of adhesive tape and plaster has long been known. Whereas small pieces may be ripped off by a quick jerk, larger pieces must be slowly soaked off with such irritating solvents as benzine and gasoline which frequently cause severe skin irritation and dermatitis.

A new solvent called Adhesol eliminates the danger of torn skin due to the ripping process, or the skin irritation due to the use of solvents. This liquid is dabbed on

with a piece of cotton and quickly softens the adhesive so that the tape or plaster may be removed speedily without danger to the skin or the nervous reaction often attendant upon the use of older methods.

APOTHEOSIS OF AIRPLANES

THE airplane has been deified. According to the Smithsonian Institution, this fact is indicated by five elaborately painted balsa-wood carvings of airplanes collected from the Choco Indians of eastern Panama. These same Indians, it will be recalled, still worship as a god a Scotch doctor, William Patterson, who treated them in the late 17th century and who was also founder of the Bank of England.

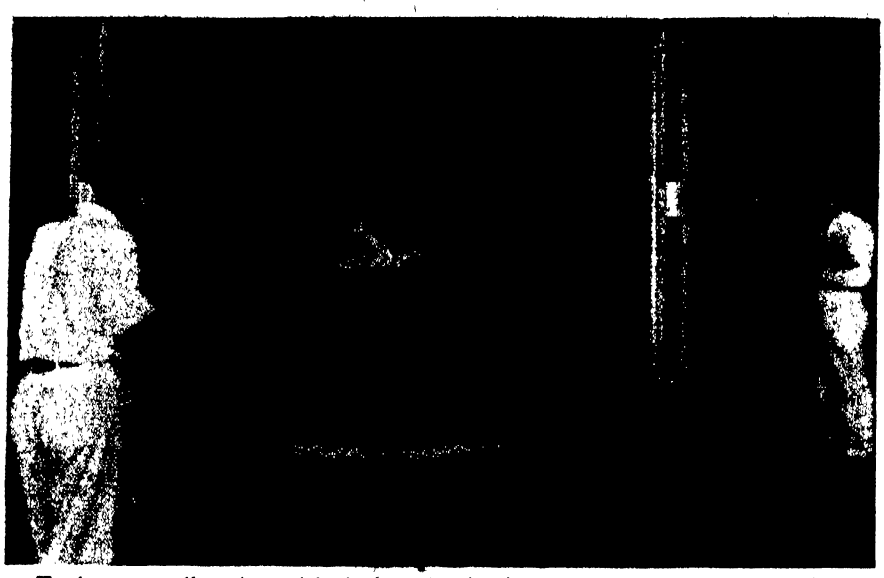
WATERPROOF MATCHES

HUNTERS, campers and fishermen may look forward to the day when their matches will not be made useless by dampness. L. E. Larson, of Jönköping, Sweden, has applied for a Netherlands patent describing the use of a water resistant resin as a binder in the heads of matches to replace the water soluble adhesives now used to hold the composition in a coherent mass.—*D. H. K.*

A VISIT TO THE LANGLEY FIELD CONFERENCE

THE National Advisory Committee for Aeronautics held its Eleventh Annual Conference at Langley Field, Virginia, recently, with the usual representative gathering of manufacturers, engineers, government officials, and university teachers in attendance. The purpose of the Conference is to allow the Committee to present the results of its researches to the industry, and to permit the manufacturers and their engineers to suggest new research problems to the Committee. There can be no argument as to the mutual benefits derived from this exchange.

The N.A.C.A. is fortunate in having perhaps the best equipment in the world at its disposal for aeronautical research and in being able to add steadily and intelligently to this equipment. Thus this year visitors were privileged to see the largest high-speed wind tunnel in the world in its final stages of construction. With a working section eight feet in diameter, the new tunnel will operate at the high speed of 500 miles per hour. The utility of such a tunnel for high-speed research is obvious. Stratosphere flying at speeds near the speed of sound may be with us in a few years, and a study of the special airfoils and other forms required under such conditions becomes imperative.



Testing a small scale-model airplane in the free spinning tunnel at Langley Field. Motion pictures of the attitudes of the model yield valuable data

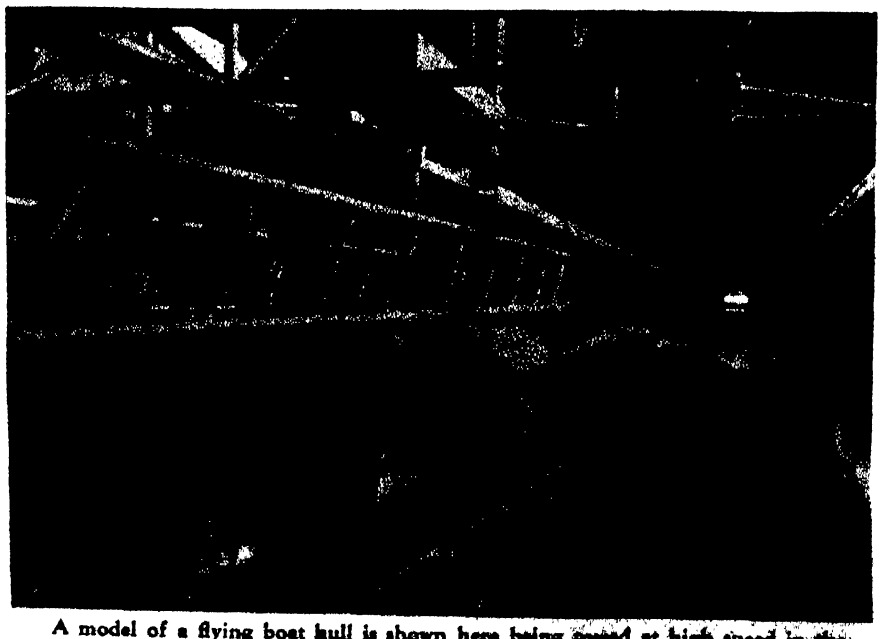
The new tunnel is built with 12-inch concrete walls with an inner reinforcement of steel plate, half an inch thick. At 500 miles per hour, the static pressure of the air in the tunnel is reduced to 800 pounds per square foot, while atmospheric pressure is 2117 pounds per square foot or 14.7 pounds per square inch. The difference is taken up by the kinetic energy of the fast moving air stream and the rugged walls are necessary to keep the tunnel from caving inwards. Incidentally, the pressure inside the tunnel is so low that it is equivalent to an altitude of 12,000 feet. The chamber in which the personnel will work and through which the tunnel proper passes is built in the form of an Eskimo igloo to resist these enormous forces, and is provided with pressure-controlled air locks.

An 8000 horsepower electric motor will be required to equip the tunnel. The motor will drive a 16-foot propeller of 18 blades. The enormous energy which is put into the airstream to overcome the friction of the walls is ultimately converted into heat. Thus a special cooling system had to be installed to keep the channel at practically outside-air temperature.

The day of miracles in aeronautical research is passing. In the future, we must expect steady improvement and refinement without such radical departures as in previous years, at least until we come to rocket flight, or flight at 50,000-feet altitude. The year's work of Langley Field brought no striking discoveries to the fore; there are, however, a large number of advances, minor in themselves but constituting invaluable knowledge as a whole for constructors and designers. The laboratories are busy all the time, and the only complaint made by visitors to the field was that they were incapable of assimilating in one day the great intellectual treat placed before them. In our story of the day's event, we can only mention the most important phases.

For high speed, propellers may have relatively small diameters; for take-off, climb, and altitude flight in thin air, the propeller diameter must be large. Accordingly, the designer must compromise. The variable-pitch propeller helps in such compromise but does not solve the entire difficulty. When stratosphere planes equipped with engines of 1500 horsepower each come into use, enormous propellers of perhaps 18 or 20 feet in diameter may become necessary—so at least was apparent from analysis of the propeller tests. The whole appearance of our airplanes may have to be changed, or else propellers will have to be built which will not only change pitch but also increase their diameters for altitude work. There is a pretty problem for our inventors and engineers.

Pilots do not like gusts and the resulting bumps, but they can stand them; passengers may find gusty flying just as uncomfortable as the rolling or pitching of a ship at



A model of a flying boat hull is shown here being towed at high speed in the towing basin at Langley Field, in order to study its operating characteristics

Part of the buildings at Langley Field. The bee-hive shaped structure in the center is the test chamber of the wind tunnel described on the opposite page

sea. Also, sufficient structural strength must be provided in planes to withstand any gust however violent. The Committee is quite rightly giving much attention to this problem and has installed accelerometers on the transport ships of all the major airlines, and thousands of records have been accumulated. Besides these accelerometer records in airline operation, Langley Field launches miniature airplanes carrying recording instruments and subjects them to artificially created gusts in the general study of the same problem.

The favorable report of the Airship Survey Committee and the successful flights of the Hindenburg are reviving public interest in the large rigid airship. It is a straw in the wind that Langley Field is almost as active as ever in aerodynamic research related to airships. One problem investigated during the past year is the forces developed during ground handling of airships. When the wind hits a ship the size of the *Macon* at an angle of 60 degrees, and at a velocity of 20 miles an hour, enormous forces are developed: the vertical or lift force is about 25,000 pounds, and the side force is about 65,000 pounds. No wonder that mechanical appliances and special tracks have to be laid down at Lakehurst for handling these monsters of the air.

Other significant researches can only be reported very briefly:

Rivet heads projecting on the underside of the hull may increase the water resistance some 25 percent, which may make a vast difference in the take-off characteristics of a heavily loaded transatlantic flying boat. This result was obtained in the large towing basin at Langley Field. Rivet heads projecting from the fore body of the hull are particularly detrimental, so the same investigation showed.

The Committee has tested hundreds of different airfoils in systematic research. Out of this vast research has come the N.A.C.A. 23012, which is recognized as the world's best airfoil, with low drag, high lift and a small movement of the center of pressure. There is scarcely a new airplane now built in the United States which does not embody this airfoil or some modification thereof.

Other researches were concerned with the design of tapered wings in such fashion that the flow over the tips did not break down at large angles, thus safeguarding against the stall and spin. The effect of propeller slipstream over the leading edge of the wing was shown to increase the maximum lift 20 percent or more. In the free spin tunnel, visual demonstration was made of how machines could be improved so as to recover quickly from the spin. A mysterious engine cowl, termed the nose cowl, was shown to visitors—but a pledge of secrecy prevents the description of this entirely novel device.—*A. K.*

100,000,000 MILES

A SIGNIFICANT milepost in aviation was passed by United Air Lines on June 17, 1936, when the company completed its 100 millionth mile of flying in over ten years of operation, becoming the first airline in the world to reach that coveted goal of flying experience. The mileage record is equal to 63 solid years of flying at an average speed of 180 miles per hour.

Exporting the Art of Soundproofing

THE United States exports a great many things to Europe, and not the least of them is soundproofing. Dr. Zand of the Sperry company has just returned from a six months' stay in England, France, and Italy where he has been successful in soundproofing some of the best known European airplanes. The French Bréguet-Wibault 18 passenger, twin-engined airplane has the distinction, thanks to his efforts, of being the quietest airplane in the world with sound intensity levels, in decibels, of 76 in the bar, 72 in the pilot's compartment, and 64 in the passenger compartment. The bar is relatively noisy, but who cares?

As a Pullman running on a smooth roadbed has a noise level of over 70 decibels, this is indeed a remarkable achievement. The Martin Clippers used by Pan American have a noise level of 69 decibels, just a trifle higher than that of the French transport.

As bigger airplanes are built, the problem of soundproofing will become less difficult. The limitations on weight of materials will become less rigid and there will also be more space available. There is no magic soundproofing material; space and bulk are the all-essential factors, although there is a distinct science in selection and installation of materials. According to Dr. Zand, modern transport airplanes are now quiet enough, and it would cost 50,000 dollars in research to reduce the noise level by only two decibels.

In the specifications laid down by the French Air Ministry (which controls all transport lines in France) particular stress was placed on comfort and freedom from noise for the pilots. This is a feature which has been somewhat neglected hitherto. The low decibel level was attained in the pilot's compartment by providing a 3½ inch space between the outside and the inside walls. All parts necessary to control of the airplane were mounted on the inner walls so that this space was completely reserved for the soundproofing work.

Another important point of soundproofing is that there must be no open windows to admit the noise of engines or propellers. Ventilation must be entirely artificial with all windows closed and of thick glass, rubber mounted. The air passing into the inlets or leaving the cabin must be scrupulously guarded from noise by carefully designed acoustic filters.

***Left:* A transport plane cabin ready for the application of soundproofing. *Above:* Same cabin finished and with passenger's seats installed**

The photographs of the Bréguet-Wibault plane give an approximate idea of the steps in soundproofing the cabin. In the bare cabin structure there are longitudinal members running the whole length of the cabin,

channeled bulkheads or frames at intervals with holes punched out for lightening, the whole structure being covered by a thin metal skin.

A sound-absorbing material called "Seapack" encased between two light layers of cloth is cemented to the skin. Since the material may at times have to be removed for purposes of inspection, a flexible cement is used so that the covers may be readily peeled off from the structure without injury. The layer of Seapack is thin and the bulkheads project beyond. Layers of felt with a considerable degree of air space are then inserted. This brings the soundproofing to the outer edge of the bulkheads. Strings running the length of the cabin serve to tighten up the fabricoid which constitutes the inner covering.—*A. K.*

The Latest Hammond

OUR readers will perhaps remember the excitement aroused by the Department of Commerce competition for a private airplane of novel type, held nearly two years ago. This was part of a program for the popularization of private flying. Now after strenuous efforts by the Hammond Aircraft Corporation and the Department of Commerce, a really useful airplane, the Model Y, has received its Approved Type Certificate or ATC as it is popularly called. The photographs show the outlines of this machine.

The large dihedral of the wing, carefully designed ailerons, and large vertical tail surfaces have worked out very well. It is possible to disconnect the rudder and fly with ease under good weather conditions with only two controls. Over 100 hours' flying without the use of rudder have been achieved on the Model Y during the last few weeks.

The pusher propeller in back of the cabin gives the occupants excellent vision. When the first version of the Model Y appeared on the scene, there was considerable difficulty in cooling the engine. This difficulty has been overcome by the scoop and tunnel placed above the cabin. The scoop placed to the left of the engine receives the dynamic pressure of the air. The rear end of the tunnel is under the suction of the propeller. Therefore air is drawn efficiently around the cylinders of the air-cooled 4-cylinder Menasco motor.

It is a sign of the times that this "private owner" airplane is equipped with a complete ventilating system and some degree of soundproofing, and that it is of all-metal construction. Our readers will notice that the tail surfaces are carried on outrigger booms *without* bracing wires. The elimination of bracing wires was made possible by adopting stressed skin tapered booms of an elliptical cross-section and the use of a strong aluminum alloy.

Experiments in the free spinning tunnel indicate that recovery from the spin occurs in a very few turns in the Model Y. This is mainly due to the fact that the vertical tail surfaces project well below the stabilizer. Thus there is no blanketing of the vertical tail surfaces at the high angle of attack attitude which a machine maintains in the spin.

The most serious criticism leveled against the Hammond Y when it first appeared was its low performance. Now the figures are much better as can be seen from the following:

Wing span, 40 feet. Overall length, 26 feet 11¾ inches. Overall height, 7 feet 7 inches. Wing area, 210 square feet. Aileron area, 14.25 square feet. Flap area, 25.2 square feet. Stabilizer area, 22.45 square feet. Elevator area, 13.28 square feet. Rudder area, 10.5 square feet. Fin area, 10.5 square feet. Fuel capacity, 30 gallons. Oil capacity, 3 gallons. Baggage capacity, 99 pounds. Pilot and passenger, 340 pounds. Two parachutes, 40 pounds. Gross weight 2150 pounds. Maximum speed, 123 miles per hour. Cruising speed at 75 percent full power, 112 miles an hour. Minimum speed 39 miles per hour.

In its refined version the Model Y will be a serious contender in the private flying market.—*A. K.*

Airplane engine synchronizer

Engine Synchronizer

IN a multi-engined airplane it is quite important to keep all engines running at exactly the same speed. Otherwise it is difficult to keep the plane on its course, and a "drumming" noise may disturb the passengers. In the past, reliance was placed on the pilot's experienced sense of hearing. Now special synchronizers have been developed. A very simple and effective type has been invented by Luther Harris of Central Airlines, and is shown in our photograph.

The device consists of a rotating white disk with nine black spots equally spaced on its face. The disk is driven by a short tachometer shaft from the central engine. Between the rotating disk and the glass front of the instrument there are two Neon tubes with a partition between them. The Neon tubes are electrically excited by the ignition systems of the outboard engines. When all three engines are at the same speed Neon flashes and disk rotation combine to give the illusion that the black spots stand still. The instrument is therefore a variant of the stroboscope which has proved both practical and effective.—*A. K.*

Gliders of Rubber

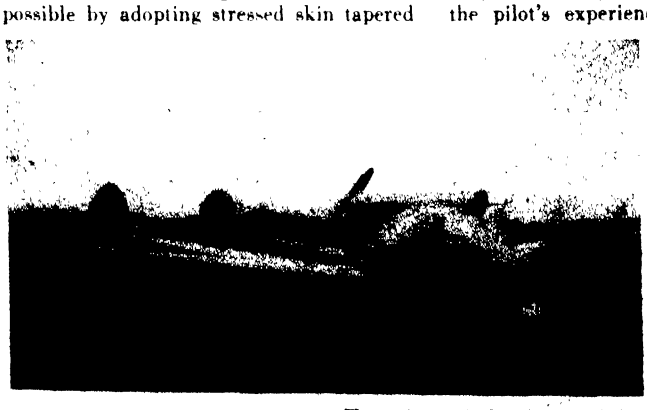
SUPREMACY in the art of the glider formerly rested with Germany. Now it has probably passed to Russia. The Soviet pilots hold the record for the number of loops executed in a glider, have made experiments in towing gliders two or more miles above the towing airplane for the purpose of meteorological observations at altitude, and have carried the use of glider trains far beyond that in any other country. Thus rumor states that glider trains are to be put into experimental operation between Moscow and Vladivostok. Now we read of another glider development fostered by a Russian engineer G. I. Grohowsky. This is a craft built entirely of light cloth and rubber. It can be folded and packed in a sack only 3 feet by 3 feet by 1½ feet. The whole rubber glider weighs less than 180 pounds. The elastic properties of rubber are an advantage in hard landings, and the watertightness of the glider permits its use in water work.

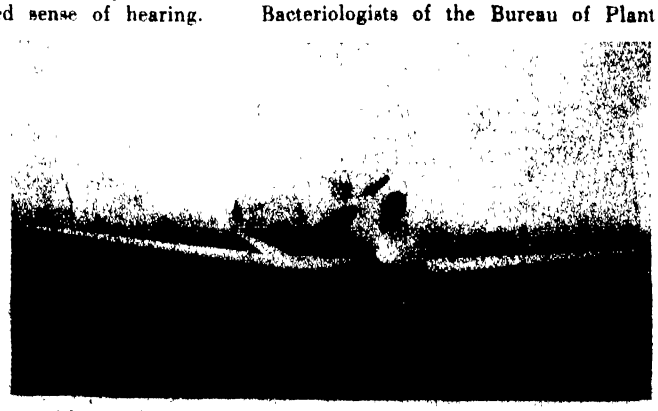
The fuselage is formed like a cylindrical balloon, tapering to a conical point at the rear, and can be inflated with air or deflated very rapidly. The wing, in one piece, is formed of rubber longerons of circular form. Air inflation also provides the contour of the wing. Only control surfaces are of the classical wood and fabric construction. This is a curious development which has possibilities.—*A. K.*

Intense Cold May Not Kill Organisms

A WARNING against careless preparation of fruits for frozen storage is found in tests just completed by the United States Department of Agriculture.

Bacteriologists of the Bureau of Plant





Two views of the improved Hammond Model Y described above

Industry—in a routine examination of frozen strawberries, raspberries, and cherries held for three years at a temperature of 15 degrees, Fahrenheit—found several species of bacteria, yeasts, and molds still alive. To study the behavior of these small organisms at low temperatures, 26 were placed in culture and held in a cold storage room at 16 degrees, Fahrenheit, for one year.

Eight of the 26 were able to grow at this temperature, 13—while showing no growth at 16 degrees—produced abundant growth when removed to room temperature for 24 hours. Only five of the 26 failed to survive the year.

These tests, say Bureau bacteriologists, point to the necessity for cleaning fruits before freezing storage as well as to the need for removing any that might carry large numbers of decay organisms.

FARMING DE LUXE

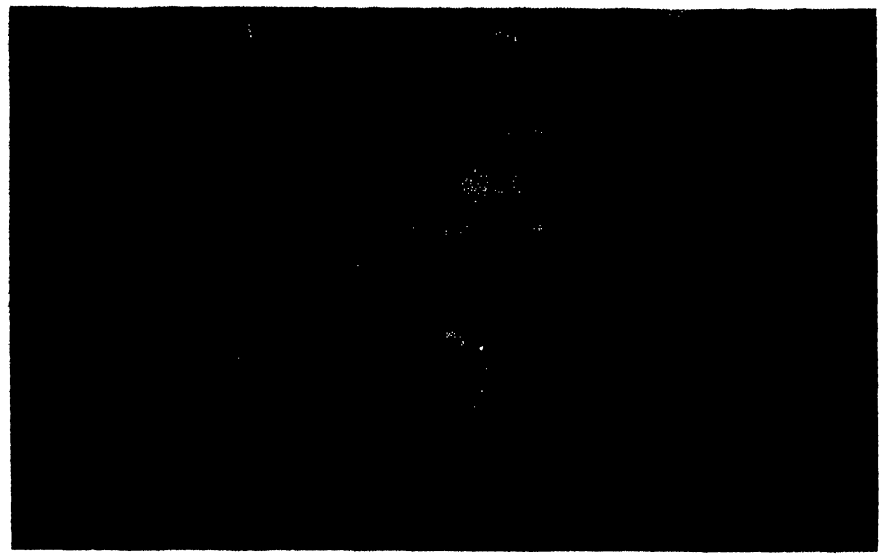
A NEW farm tractor designed to use standard motor gasoline is equipped with every convenience of a modern passenger automobile, including self starter, electric lights and radio, and at the same time gives very high economy in plowing.

Another Cyclotron

UNDER the direction of Professor L. A. DuBridge, the University of Rochester has installed cyclotron or "atom smashing" equipment for use in experiments on atomic disintegration.

As in all equipment of this type, iron and other metals have an important rôle. In the Rochester laboratories, the magnetic circuit is made up of six annealed Armco ingot iron forgings, a product of The American Rolling Mills Company. The four rectangular forgings making up the yoke are 12 by 26 inches in cross-section. Cylindrical forgings used for the pole pieces are 26 inches in diameter.

Overall height of the magnet is about six feet, overall length is eight feet, and the depth is two feet two inches. Weight of the iron is about 15 tons. The magnet is excited by two copper coils containing nearly four tons of copper taking a current of 400 amperes at 110 volts. The tips of the pole pieces are 21 inches in diameter, and the magnetic field across a three-inch gap is 21,000 gauss.



The new cyclotron for the University of Rochester

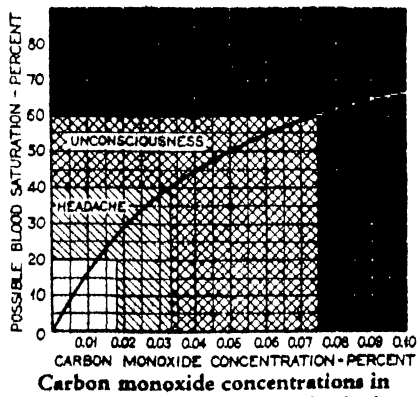
Between the pole pieces of the magnet will be placed a metal vacuum chamber weighing about 500 pounds, in which hydrogen ions can be accelerated to an energy of 5,000,000 volts.

The cyclotron can be used for the atomic disintegration of any matter. When the coils are energized, the magnetic flux causes the atom to travel in a spiral. In some cases the atom attains a speed of 20,000 miles an hour. When it reaches the outer extremity of the cyclotron, it strikes an obstruction and disintegrates.

A portable carbon-monoxide detector testing air in a motor bus

Detecting Carbon Monoxide

ACUTE danger from poisoning by carbon monoxide, the insidious poison in manufactured gas and in the exhaust from automotive engines, is based on the fact that the blood of persons and warm blooded animals absorbs dangerous amounts of the gas from concentrations so small that no simple chemical means for their detection has been found. The value of a method sensitive enough to detect low quantities of the gas is amply attested by the number of inquiries for such a method or device. Carbon monoxide detectors now on the market which have the necessary sensitivity to insure absolute safety are either too delicate or too expensive for general use.



Carbon monoxide concentrations in air, and their effects on the body

So sensitive are persons to poisoning by carbon monoxide that concentrations as small as 13 parts of the gas in 100,000 parts of air may cause headache and above 33 parts per 100,000 may cause unconsciousness. Naturally, the extent of the injury to the person exposed to carbon monoxide gas depends upon the amount actually absorbed by his blood and this depends not only on the concentration of the gas in the air he breathes but also on the amount of it he breathes. The accompanying chart shows the possible saturation of the blood on exposure to various small concentrations of the gas.

Below 17 percent blood saturation, symptoms seldom develop. Between 20 and 40 percent, the symptoms are headache and mental and physical dullness, with unconsciousness occurring between 40 and 60 percent blood saturation. Above 60 percent saturation, death occurs. Resuscitation measures are usually successful when applied during the second stage.

Obviously, the only guide to the extent of the injury to a person is to be found in the state of his blood. For this purpose, a rapid method has been devised for analysis of the blood of a suspected victim of carbon monoxide poisoning. Such a test can be made in a very few minutes and serves as a guide to the application of proper first aid measures.

The detection of extremely small concentrations of carbon monoxide can be similarly done quickly but it is necessary to observe that *any* indication whatever of the presence of the gas is a warning of danger since there are actually no "safe" concentrations. Using Hoolamite (activated iodine pentoxide) in a properly protected ampoule, carbon monoxide can be detected in concentrations as low as 50 parts per 100,000 of air by the change of color of this material from a grayish white to a shade of green, the depth of which depends on the concentration of the gas. The apparatus for making this test is easily portable and weighs but a few pounds. A similar method which is less accurate in determining actual concentrations but which indicates a concentration of 30 or more parts per 100,000 is also to be had. It depends on the reaction of palladium compounds.

The accurate measurement of very low concentrations of carbon monoxide depends upon the heat liberated by burning the gas over a Hopcalite catalyst. Instruments em-

ploying this principle to give an alarm on exposure to tiny concentrations of the gas are necessarily more complicated and delicate than the simpler ones depending on a color change. Delicate electrical instruments measure the minute change of temperature produced and an electrically driven motor pumps the gas sample through the apparatus. These devices are built to use electric current from an external supply or from a built-in storage battery.

All of these instruments are widely used in places where there is danger from carbon monoxide. Their value depends upon the fact that exposure of several hours is required to produce symptoms at even higher than minimum concentrations of the gas.—*D. H. K.*

'QUODDY

DR. Karl T. Compton estimates that the Passamaquoddy Tidal Power Project would, if ever completed, represent an investment of 1500 dollars per kilowatt as compared with an investment of 100 dollars per kilowatt for an equivalent steam power plant. Modern steam plants have been shown to be less costly even than hydro-electric plants.

Four Tons of Periodicals

ONE of our readers, Mr. Vernon H. Springsted, of Schenectady, New York, recently wrote to us regarding a bound volume of Scientific American for the full year 1858, which was found among the effects of a man in a small village near his home. He added a note which seems to have unusual interest:

"The heirs of this man," wrote Mr. Springsted, "found that he had very carefully preserved almost every newspaper and magazine which he had purchased during his lifetime, and filed them away very carefully in the attic of his home. Out of curiosity the accumulation was weighed and found to exceed four tons."

Cast Steel Crankshafts

ALTHOUGH used for more than two years, the cast alloy-steel crankshaft of Ford V-8 car and truck engines is still unique in present day automobile manufacture. The shaft material has been defined as a "high-carbon, high-copper, chrome-silicon alloy steel." Each of the alloying metals, in addition to the carbon content, gives the metal certain desired characteristics after the shafts have been heat-treated, such as rigidity, good bearing surfaces, and resistance to shock.

Upper left: **A group of cores which, when assembled, form a mold for casting four steel crankshafts in one operation.** *Left:* **A series of crankshaft molds assembled in place on a conveyor, ready for pouring.** *Below:* **A single casting of four crankshafts, as removed from the mold, showing the gates and risers**

Four shafts are cast vertically in each baked sand mold. Although called a "mold," it is in reality a stack of 16 "cores," the top core serving to hold the excess metal required to fill spaces caused by contraction in cooling and to cause a whirling motion in pouring, which prevents washing away or grooving the mold. The molds are stacked and carried on moving conveyors to the pouring line and remain thereon until the shafts have cooled to a dull red temperature.

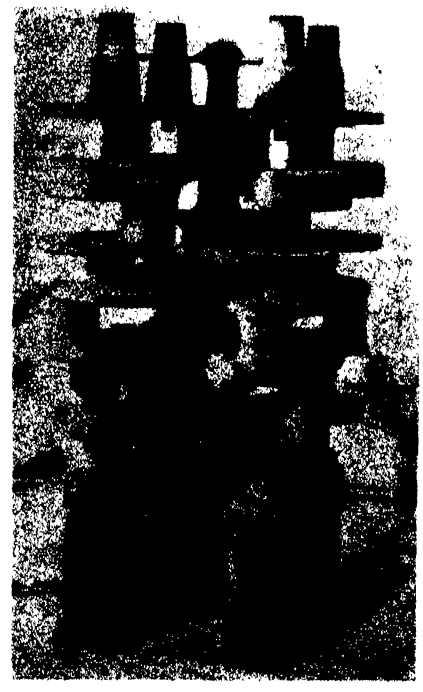
The metal is prepared in four 15-ton electric furnaces, each consuming 10,000 to 12,000 kilowatt-hours of electric current per eight-hour shift. It is then transferred to pouring ladles, each containing about 1300 pounds of steel, sufficient for three molds or for 12 crankshafts. The pouring temperature range is closely controlled between 2670 and 2700 degrees, Fahrenheit. The cluster assembly of four crankshaft castings weighs approximately 430 pounds in the rough state, including gates and risers. The furnace and other foundry equipment are sufficient for a production of 6500 crankshafts daily, requiring in excess of 50 tons of metal.

Since the shafts are not straightened after casting, they must be cast straight originally, if the minimum amount of metal is to be left for removal in machining. The four crankthrows also must be spaced 90 degrees from one another in the finished shafts. This requires the introduction of purposeful errors in the shape of certain parts of the mold to counteract the effect of expansion and contraction of the steel in solidifying and cooling.

After normalizing and heat-treating, the shafts have an ultimate strength of from 128,000 to 130,000 pounds, with an elastic limit of from 88,200 to 96,500 pounds. They can be twisted from six to nine degrees without permanent deformation and have a hardness of from 255 to 321 Brinnel. Each shaft is given an impact test to detect incipient flaws before machining and is also checked for desired hardness.

After machining, the main and connecting-rod bearing journals are ground to close limits. Every shaft is inspected for concentricity and alignment of bearings within a limit of 0.001 of an inch.

Following this and other rigid dimensional inspections, all shafts are accurately balanced, both statically and dynamically,



the total permissible unbalance being 0.2 inch-ounces at one point of reference. The shafts are of the "fully counterbalanced" type, wherein not only is the weight of opposing crankthrows compensated for, but the weight of the connecting rod bearings and that part of the connecting rods which rotates is also considered. Even the weight of the oil within the hollow crankpins is included in the balancing operations.

Finally, the bearing surfaces are polished, the shafts being revolved in the same direction they rotate in the engine in order to make the "grain" of the final finish conform to actual conditions of use. Additional inspection, flushing out of oil holes and placing the finished shafts on rubber-cov-

ered conveyor hooks to prevent damage to the surfaces, completes the manufacture.

Compared with the forged shafts, the excess metal removed by machining is 9.5 instead of 15 pounds, the cast shafts weighing 72 pounds, and the forged shafts 80 pounds in the rough state. The finished cast shafts weigh 62.5 pounds. The forged shafts weighed 65 pounds finished, the cast shaft being 2½ pounds lighter. The time saved in machining and grinding is 20 minutes, five minutes on machining and 15 minutes on grinding, most of this because no straightening is needed.

TWINS

TWINS are most common in Denmark and least common in Colombia, while the United States is near the average in its twin records. Twins occur once in 63 births in Denmark, once in 250 births in Colombia, and once in 87 births in this country. The world average is one set of twins in 85 births.

Piston Dispersion of Stones in Concrete Roads

IN Norway there has been developed a new method for the construction of concrete road surfaces which has proved to be advantageous with regard to saving labor and time. The method, which has been invented by Alfred Holter, Director of the Dalen Portland-Cement Factory of Brevik, Norway, briefly consists in the following:

After the road surface has been suitably prepared, a layer of sand-cement-mortar is spread thereon to a thickness of from three to five inches. On the top of this layer is placed a second layer of crushed stone of about the same thickness.

The stones from the upper stone layer are then pressed downwards into the underlying layer of mortar by means of pistons or plungers, which may be located on the surface of a cylindrical roller. The cylindrical roller usually is mounted in a truck adapted to roll on side rails, between which the layers of mortar and stones are placed on the road surface.

An accompanying diagrammatical sketch illustrates the method, one photograph shows the machine in operation, and a second photograph shows a road built by this method being completed.

The cost of these concrete road surfaces has ranged from a little over $1.00 up to $1.25 per square meter with a thickness of four inches of the finished concrete covering.

With one complete set of machinery it has been found possible to complete about 1000 square meters in seven hours with 15 men, and the road surface has been found to be ready for traffic about 24 hours after starting the operation.—*Dr. Alf B. Bryn, Oslo, Norway.*

Parasites to Fight Fruit-Fly Cross Ocean by Air

VICTORY in a battle involving millions of dollars in potential business may depend upon 19 tiny insects of two species carried to Honolulu from Africa aboard a Clipper plane by the United States Department of Agriculture.

The tiny wasp-like insects known as *Opius* and *Hedylus* are parasites of the Mediterranean fruit fly and have a reputation for being death to the flies. If *Opius* and *Hedylus* live up to their reputation, federal scientists believe it may be possible to eradicate the fly which infests several types of island-grown fruit. If the fly can be eradicated the quarantine against shipping some kinds of fruits to other parts of America may be lifted, resulting in a decided stimulus to production in Hawaii.

The insects arrived just three weeks after leaving Sierra Leone on the west coast of Africa. Two hundred left Africa by boat but only 19 arrived alive. During their journey halfway around the world they were kept in a specially constructed container and fed on lump sugar and water. Most of the casualties resulted during the trans-shipment from the boat at Philadelphia to the New Jersey station, it is reported.

Importation of the insects resulted from a trip made to Africa by R. H. Van Zwalenburg of the Hawaiian Sugar Planters Association who was sent to find fruit fly parasites. Other scientists from Hawaii are in various parts of the world seeking parasites under the auspices of the AAA program in the Territory.

A container of tiny insects shipped by air to battle fruit flies

Although only 19 arrived alive, they have a few relatives in Hawaii that came by the more prosaic steamer route. At present 493 of the potentially important insects are being cared for by federal officials prior to their release on the various islands of the Territory.

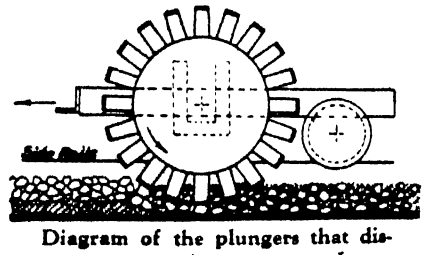


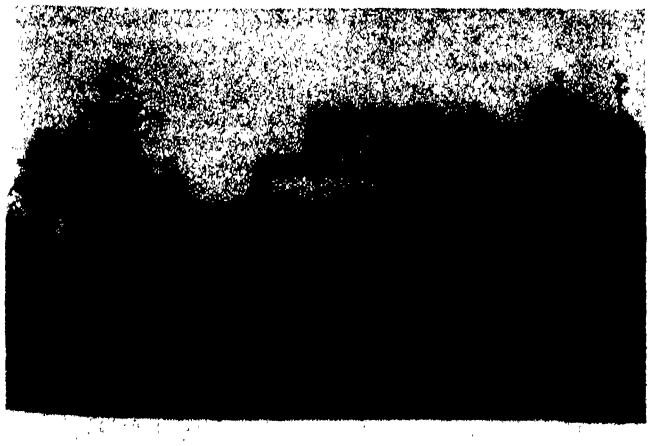
Diagram of the plungers that disperse stones in concrete. *Lower left:* The machine in use. *Lower right:* Finishing a road surface

Cold Sensitiveness Causes Swimming Danger

DANGER lurks at the bathing beach for those unfortunate persons who are hypersensitive to cold. Facts about this peculiar condition were shown by Dr. Bayard T. Horton of the Mayo Foundation for Education and Research, Rochester, Minnesota, in an exhibit of the American Medical Association.

Nearly half of the persons studied collapsed after they had been in swimming, and some had to be rescued from the water. Besides the general reaction, which may cause collapse and unconsciousness, discoloration of the hands and feet and marked flushing of the face may occur. In one patient, the temperature of the cheek increased several degrees at the height of the reaction. Cold air as well as cold water brings on the condition in susceptible persons.

Experimental studies showed that the reaction is a chemical one. The effect of the cold is apparently to increase the



amount of histamine in the blood. This substance, which occurs naturally in the body, produces similar disturbances of the circulation when injected into the blood stream.

Persons susceptible to cold can be desensitized by short daily immersions of the hands in cold water.—*Science Service.*

Nature's Tiny Dams Stop Floods at Grass Roots

FLOOD control begins at the grass roots, say soil conservation men in the United States Department of Agriculture. What they mean is that run-off should be controlled for an entire watershed, from the crest of the hills right down to the mouth of the rivers.

In the uplands, at the headwaters of all streams, nature, if undisturbed, retards run-off by throwing across practically every foot of land under forest or grass cover—a maze of "slow," "stop," and "detour" signs—an interlacing system of tiny dams. A dead leaf, a blade of grass, or a root tangle stops a raindrop from running—changes its direction again and again, makes it creep away. Floods are made up of raindrops infinitely multiplied and brought together in a hurry.

Farmers are adapting nature's method of flood control when they keep their fields rough and plant soil-holding water-impeding crops. In contour farming each furrow, each tiny harrow scratch, becomes a small dam or terrace—doubly effective when reinforced by grass cover.

Department conservationists do not offer "flood control at the grass roots" as a substitute for dams and spillways farther down the valleys. They offer it as a reinforcement, because it makes water creep away and in so doing stores most of it in that greatest of all reservoirs, the soil.

Cellophane Balloon

JEAN PICCARD, stratosphere balloonist and research associate of Bartol Research Foundation of the Franklin Institute, has constructed a balloon of Cellophane to continue explorations of the stratosphere. The balloon so far built will carry only instruments aloft but it is hoped that experiments with it may yield important information both as to cosmic rays and other conditions in high altitudes and as to possibilities of better balloons. Cellophane, familiar wrapping on many commercial articles and packages, is made from wood pulp in a manner very similar to that which produces rayon, the difference being principally in the fact that the former is congealed from the syrupy liquid cellulose xanthate compound in a sheet instead of in fine filaments.—*D. H. K.*

The water in the pitcher, almost a quart, was squeezed from the six and a half inch long sponge in the foreground. The sponge, made of cellulose by Du Pont, has many uses

Brief Case Drawing Board

SENSING the need of engineers, draftsmen, contractors, designers, artists, students, and others for an efficient, compact and easily portable drawing board, H. E. Twomley has developed one that is unique. This board is only one quarter of an inch thick, requires no thumb tacks, and dispenses with a "T" square.

The illustration shows the essential features of the board. Made of pressed fiber board, Masonite, its drawing surface is recessed sufficiently to give a raised edge on each of the four sides to engage the edge of a triangle for both vertical and horizontal lines. Steel spring clamps at each of the four corners clamp the corners of the drawing paper tightly, and the corners of the raised edges beside these clamps are rounded so that the triangle will ride over them without catching.

Drawing board of novel design

This new board is made in three sizes, the smallest being the one for 8½ by 11 inch paper shown in the illustration.

Don't Force a Child To Eat

THE common maternal mistake of forcing a child to eat was attacked vigorously by Dr. Clifford Sweet of Oakland, California, at a recent meeting of the American Medical Association, reports *Science Service.* Malnutrition has been over-emphasized until it has become a menace to the peace of mind of mothers, Dr. Sweet declared. The battle waged at many a meal provides an atmosphere for the development of any and every sort of behavior problem.

One method used by Dr. Sweet to study the problem is to have parents let the child direct his own eating for three weeks while the parents keep a record of what and how he eats. The mother often finds that her child is eating more than she thought. Sometimes Dr. Sweet had trouble getting the last week's record because the problem had disappeared and the mother lost interest in keeping the record.

Definite faults in eating can usually be corrected by proper methods, Dr. Sweet indicated. The child who does not like meat usually has not learned to chew it sufficiently to swallow it. Taking away foods the child says he does not like sometimes has a magic effect; he may soon ask for them.

"I am certain," Dr. Sweet concluded, "that no normal healthy child can long resist the demands of his body for food when there is added to it the example of the other members of the family eating the food that appears on the table or omitting it without remark, in an atmosphere of comradeship and enjoyment."

Even the wheelbarrow has been improved. The one shown is made of aluminum alloy and equipped with a rubber tire. The four and a half cubic foot size weighs 36 pounds

SAPPHIRE WINDOWS

WINDOWS of synthetic white sapphire about ¼ of an inch in diameter are being used to provide openings through which scientists can look into automobile cylinders and study what is happening. This material shows the best mechanical strength, transmission of visible and invisible light rays, and resistance to chemicals of any material used for this purpose.

Direct Flame Evaporation

FLAMES burning actually below the surfaces of solutions are solving problems of evaporation in chemical manufacture otherwise impossible to solve economically. Experiments conducted at the University of Washington, Seattle, Washington, have demonstrated the effectiveness of submerged flames in evaporation of liquids commercially which under other conditions crystallize so badly that heat is wasted in large quantities in the process. By using this method of evaporating solutions, natural deposits of sodium sulfate and sodium carbonate are made commer-

cially available since the economy of the process permits recovery of these compounds at a low enough cost to be economically attractive. The same method has been previously applied to the evaporation of viscous and tarry liquids which are difficult to concentrate by other means. - *D. H. K.*

Agricultural Imports

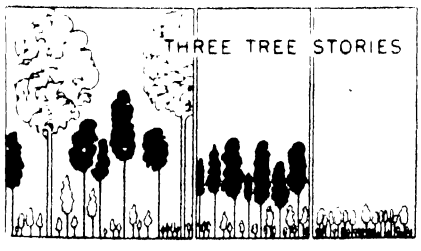
IN our December issue, we pointed out editorially that while our agricultural exports for the first nine months of 1935 had shown an astonishing decrease as compared with the same period of 1934, our imports had shown an equally alarming increase. In response to requests for data on the complete year 1935, we are therefore giving below these figures:

IMPORTS:	*YEAR 1934*	*YEAR 1935*
Wheat (60 lb. bu.)	15,848,356	38,870,398
Lard, animal oils & fats	2,001,447	18,895,241
Butter (lbs.)	1,253,392	22,674,642
Corn (56 lb. bu.)	2,959,256	43,242,296
Canned Meat (lbs.)	46,780,678	76,653,242
EXPORTS		
Wheat (60 lb. bu.)	16,970,089	232,965
Lard, animal oils & fats	439,515,302	111,914,091
Butter (lbs.)	1,219,713	957,701
Corn (56 lb. bu.)	2,987,419	177,382
Canned Meat (lbs.)	16,361,812	12,563,973

Trees Grow More Timber When Sharing Sun

MAN can help Nature in the reproduction and growth of good timber. Finding out how to help most effectively is one of the principal jobs of the Forest Service, United States Department of Agriculture. Sunlight and water are vital to healthy tree growth.

The accompanying diagrams illustrate three conditions common on forest lands. Where the overstory trees (those trees



which overtop the rest) monopolize sunlight and soil moisture, young new growth does not come in and the understory stagnates. The first diagram shows an overstory of old growth where old, mature, and defective trees may be getting more than their share of a limited place in the sun, to the detriment of the second-growth and new-growth. The second represents an overstory of second-growth monopolizing the light with new growth again as the victim. In the third diagram, an overstory of new growth itself is overtopping smaller new trees.

For rapid growth and maximum timber production, foresters seek to maintain a desirable balance of old growth, second growth, and new growth. Several types of general forest stand improvement measures are listed by the Forest Service:

Cleaning—Cutting made in a stand not yet past the sapling stage (that is, in new growth) for the purpose of removing shrubs and herbaceous growth, vines, and trees of undesirable form or species that are injuring or are likely to injure promising trees.

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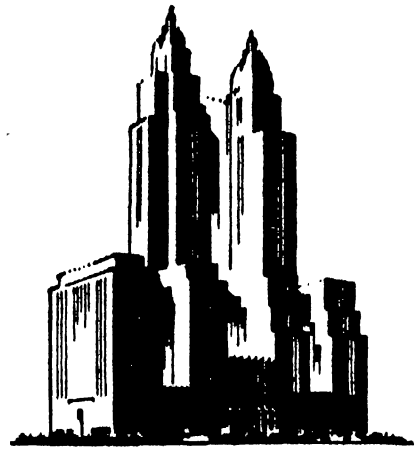

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THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

BY special request, Russell W. Porter, Associate in Optics and Instrument Design at the California Institute of Technology, in the notes which follow, gives the amateur telescope maker a few first intimate glimpses into the operation of the grinding machine for the 200-inch Pyrex telescope disk in Pasadena, California. He writes:

"A general description of this machine will interest any amateur who has made a reflecting telescope.

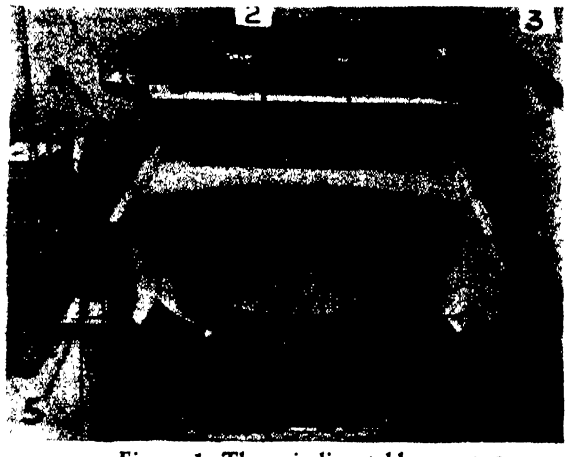

Figure 1: **The grinding table**

"In Figure 1, 1 is the table on which the disk will remain throughout the grinding, polishing, and figuring—in fact it is the cell of the telescope tube itself, and the mirror will never leave it after it is finished. The individual supporting units are not shown. The table is on trunnions that allow the mirror to be brought to vertical for testing.

"The grinding and polishing tools are controlled by a rotating spindle or driving pin, attached to the trolley 2. This trolley moves back and forth transversely on the bridge 3. This bridge in turn travels longitudinally on tracks 4, attached to the main frame of the machine.

"The driving mechanism for both the trolley and bridge motions is the scotch yoke. Figure 2 looks down on the trolley yoke, and Figure 3 is a side view showing one of the pair of yokes that move the bridge. The tracks supporting the bridge are extended at the rear of the machine so that polishing tools may be well away from the table for warming the pitch facets preparatory for hot pressing, and also for washing off the grinding tools.

"At 5, Figure 1, is the control station where the operator has complete electrical control of all the various motors and motions.

"The maximum stroke is 6 feet for the trolley, and 6 feet for the bridge. When used together, the tools may be made to move in a variety of strokes. Speeds on the track are from 8 to 25 feet per minute.

"Figure 4 shows the full size tool in process of being covered. When ready for grinding it will be covered with 1928 glass facets cemented to its convex surface. As is generally known, the 200-inch disk was cast in an open mold and hence its surface is approximately flat. Some 3¼ tons of glass will have to be removed to bring the mirror to its spherical shape. The sagitta or depression amounts to 3.8 inches. Small size cast-iron tools will be used for roughing out the curve before using the full size tool.

"The first operation on the disk will be to place it face down on the table (which is covered with 2 inches of sponge rubber) and carefully calibrate the positions of the 36 holes destined to receive the supporting units that will carry this 17 tons of glass internally at all inclinations to gravity. The holes will then be ground out, the back ground, and the edge ground. The disk will then be turned over and the rough grinding of its surface commenced.

"The 120-inch flat disk received earlier has a machine of its own, similar to the machine here shown, but smaller and with a different driving mechanism. The disk at present is fine ground, and flat to 0.00012 of an inch (concave). Its flatness was controlled during grinding by testing its surface with a stretched piano wire, but sufficient reflection was obtained at grazing incidence to allow an optical check test which confirmed those of the piano wire. Polishing and figuring this ten-foot flat will not be started until the 200-inch mirror is figured spherical, the reason being obvious to mirror makers who have made flats for testing at the focus.

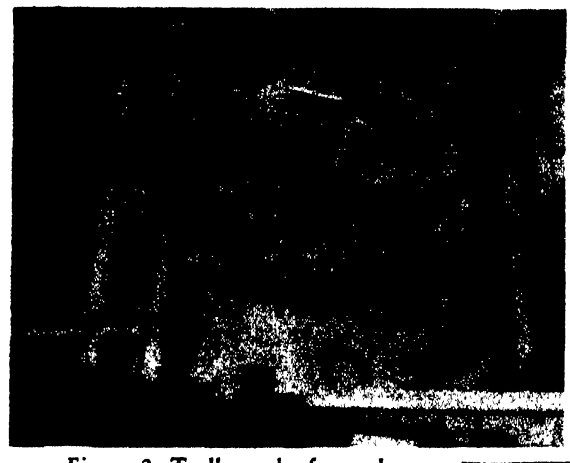

Figure 2: **Trolley yoke from above**

"The room in which the work is done is 165 feet long, 52 feet wide, and 39 feet high. The walls are covered with cork insulation. There are no windows. The room is illuminated from overhead by electric lights in the roof, and by mercury vapor lamps around the walls. The air is conditioned, washed, tempered, and given the requisite amount of humidity. The opticians like to work in a rather high humidity and a temperature of about 70 degrees.

"A visitor's gallery is provided, separated by a glass partition, so that the public may see what is going on at any time. I never go into the optical shop—and I go there quite often—without seeing several faces glued to that glass partition, evidently wondering what it is all about. And you will find them there for the next four years—the scheduled time for completion."

NUMEROUS readers have asked us why we did not, beginning several years ago, publish the data about the design of the 200" telescope. The reason was that, while the project was announced several years ago, the design was not settled—it had only been begun. It will be understandable why those who have had the most to do with it did not wish to rush into print at each successive stage of the constantly changing evolution. Now that most of the design has been settled and actual construction begun, we hope occasionally to give our readers some of the homely details, written not as the average news reporter would describe them for a general audience but for the telescope maker.

AMONG amateur telescope makers and doers of practical things in England is F. J. Hargreaves, Director of the Photography Section of the British Astronomical Association—an amateur association which we have previously urged American amateurs to join in order to obtain the monthly *Journal*, which is a live one. Mr. Hargreaves now sends us from *Mirastelle*, Woodland Way, Kingswood, Surrey, England, the following communication:

Figure 3: **Side view of machine**

Figure 4: **Making the big tool**

"The purpose of this letter is to enlist your help in a matter which I and some of my friends have very much at heart. I refer to the systematic observation of the surface features of Jupiter. This subject also supplies an answer to the question in the second paragraph on page xi of 'The Book.'

"The systematic observation of Jupiter seems to be indigenous to this country. Observers elsewhere make occasional observations, sometimes of great value, but nowhere else, so far as I know, do observers watch the planet on all available occasions, for hours on end, timing the transits of markings across the central meridian.

"The trouble, however, is that England lies in high northern latitudes, and when Jupiter is below the equator the opportunities for observing it here fall off grievously. Last apparition, for example, my total of transits was only 220, as against 1500 and more in previous years. The present apparition will be worse.

"There is nobody in the southern hemisphere interested in this work, unfortunately; although we have made many efforts to rouse our brothers in South Africa and Australia to action, there has been no adequate response.

"Now the United States extends a good way south, and conditions even in the northern states are much more favorable than in England when the planet is in low southern declination, as at present. Largely owing to your efforts, there must now be hundreds of people in America who have made good telescopes and who would be glad to know of some useful astronomical work that they could undertake. Any telescope of 6 inches aperture and upwards is suitable; I have obtained as many as 60 transits in a single evening and also many detailed drawings with a 6½-inch reflector.

"Apart from latitude, there is the scarcely less important matter of longitude. Even under the most favorable conditions we can observe only for about 10 hours; for the next 14 hours the planet is below the horizon. As the rotation period is just under ten hours, you will appreciate that there are necessarily large gaps in the records of observers grouped on a small island. If we had similar observers in a widely different longitude, these gaps would be filled.

"The observations themselves require, apart from a telescope, only a clock or watch showing Greenwich Mean Time to the nearest minute, or local time if the observer will correct for his longitude. The observer must learn the names of the various belts and zones, and of course must have a good planetary eye and sound judgment. Men who see Mars covered with cobwebs (but cannot see the large markings on that planet) are not as a rule useful as Jovian

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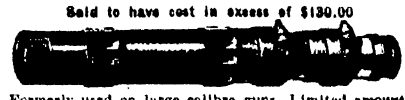

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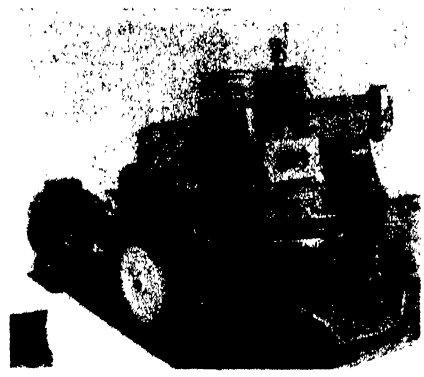

Figure 5: **Vard dividing engine**

observers. The observer notes that a dark marking of some kind on the North Temperate Belt, for example, is a little to the right of the central meridian. As it moves towards the left there will be a time when it appears to be exactly central of the belt. It is then on the central meridian, and the time is noted thus:

D spot N T B $8^h\ 24^m$,

or whatever the time was.

"If it is a hump on the south edge of the North Equatorial Belt it would be described as

Hump S edge N E B

"The list of such observations can be diversified by sketches of details, or whole-disk drawings. If the separate observations are numbered serially throughout the apparition, the objects in the sketches can be identified by a reference to the serial number.

"Apart from actual observing, the observer will also be required to reduce his observations to longitude (zenographic) by the aid of tables in the 'Handbook' of the B.A.A. This is tedious, but requires nothing more of mathematics than simple addition and subtraction. Finally, observers undertaking this work would be welcomed as members of the B.A.A., although naturally this is not a requirement but only an invitation.

"Observations such as these, however simple they may seem, are of very great importance for a study of the movements of the various currents on Jupiter. They are interesting in themselves, as the observer can easily follow the various currents and their changes by plotting his own observations on squared paper, and if several observers are in touch with one another by correspondence the sporting spirit is easily aroused and they vie with one another in the matter of numbers of observations.

"The present Director of the Jupiter Section is B. M. Peek, of *Sohan*, Silhill Hall Road, Solihull, Warwickshire, England. I am writing for him, because I have already been in communication with you and am an A.T.M. He will supply all the necessary information to anyone interested."

ON page 65 of the earlier editions of "A.T.M." is a somewhat old picture of Vard B. Wallace, and now from the same Mr. Wallace, who writes on the letterhead of the "Vard Mechanical Laboratory—Scientific Instruments," 3135 Blanche St., Pasadena, Calif., we receive a description of a neat engine for dividing setting circles and making protractors, made in his laboratory.

"The table of the engine (See Figure 5) is a little more than 14" in diameter and has 360 teeth cut on the edge. The table is split through the center line of the teeth, so that the upper half may be rotated with respect to the lower half. After the teeth were hobbed (in the Astrophysics shop at 'Cal Tech') the two halves of the gear were shifted and lapped 144 times in different positions. The ultimate result was that there is no visible error in the teeth in any position when viewed through a glass.

"In Figure 6, at the left you will note a pair of cams on the same shaft as the crank. These cams actuate two pistons in small hydraulic cylinders. The liquid from these two cylinders flows through the tubes to the tracelet mechanism. One tube connects with a cylinder that moves the tracelet back and forth. The other raises the tool on the back stroke so that it is free of the table while the latter is turning. This will seem like a needlessly elaborate device till you consider that it is necessary to shift the whole tracelet mechanism laterally on the bridge to accommodate large or small protractors. It is required that the tracelet be raised and lowered to take

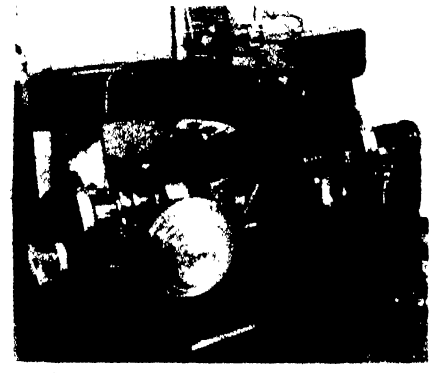

Figure 6: **Other side of Figure 5**

thick or thin work. On top of all that it is also necessary to be able to rotate the tracelet so that bevel or even cylindrical work may be done. With the hydraulic system, all this is accomplished with no difficulty other than the slight bending of the tubing. To do the same thing mechanically is quite a task.

"The machine is almost silent in operation. The engine will scratch 360 lines on a disk in about 14 minutes, putting long and short lines in their proper places, and upon completing the disk it will shut itself off and ring a buzzer for attention. You will notice that the tracelet is inclined at a slight angle in the pictures. This was for some bevel work that we do in production."

FROM time to time we receive inquiries about apparatus for making setting cir-

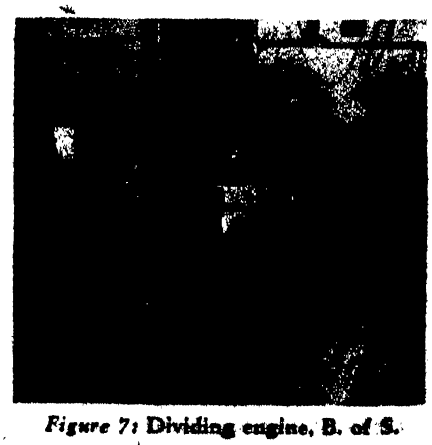

Figure 7: **Dividing engine, B. of S.**

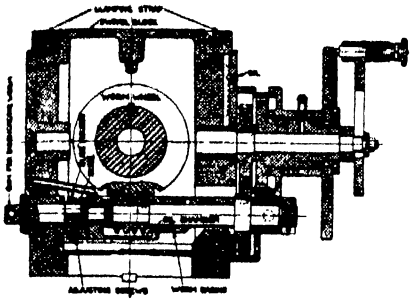

Figure 8: Dividing head principle

cles. The Vard apparatus, just described, is of course very far too fine an instrument to construct just to make circles for a telescope or two—in fact it is a finer instrument than most telescopes themselves, and then some. The one in Figure 7 goes still farther, being the circular dividing engine at the National Bureau of Standards and about the last word in such things. It can be used to graduate circles up to a meter in diameter. Such a machine costs about 10,000 dollars or more, and will graduate so that the errors are only about one second of arc and in some cases even less. This is better than a millionth of a circle.

In good machine shops dividing heads are used as attachments to milling machines for all sorts of fancy purposes. Figure 8, reproduced by courtesy of the Cincinnati Milling Machine Company, shows how these work. The handle at the right has a spring pin that drops into holes evenly spaced around a circular index plate. Through the gears shown in section it actuates a worm and worm wheel, the work being attached to the shaft of the latter. Such rigs cost well up into the hundreds of dollars.

Figure 9 shows a dividing head plus a divider that divides to one second of arc, and is made by Kearney and Trecker. The cost is about the same as that of a medium-priced motor car. Most amateurs are lucky even to get a look at one, like a cat and a king. Amateurs desiring to divide setting circles may, however, rig up their own dividing heads. (To be continued in "A.T.M.," Vol.II.)

MEMBERS of the Louisville Astronomical Society want a 20" telescope and the Corning Glass Works will reduce price of Pyrex disks to about $80 each, provided five can be made at same time. Walter L. Moore of that society, who is Associate Professor of Mathematics at the University of Louisville (summer address Box 163, R.F.D. 1, Coral Ridge, Ky.), wishes to get the necessary five buyers together. Write direct to him, please, and enclose stamp.

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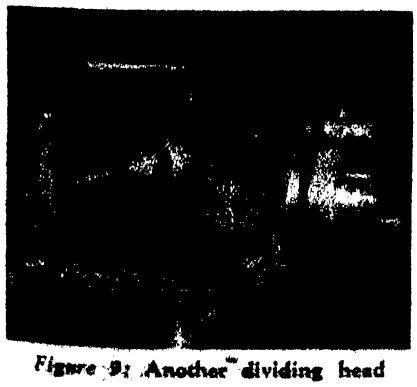

Figure 9: Another dividing head

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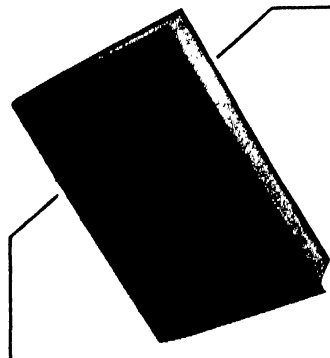

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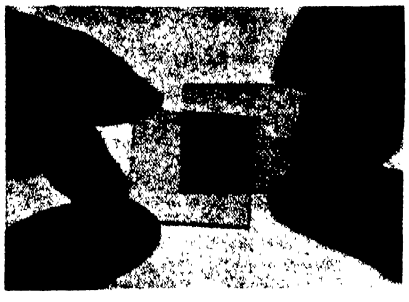

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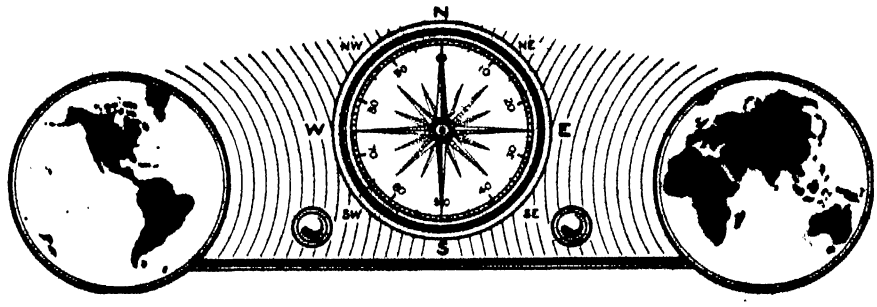

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Editor, *All-Wave Radio*

Summer Reception

THERE are occasions during the summer months when reception in the standard broadcast band is disturbed by heavy static or the severe electrical impulses induced in the antenna by nearby thunderstorms. It is during these periods when the shorter wavebands prove of real value.

Natural static and disturbances from electrical storms are not uncommon at short wavelengths, but there are many instances when interference-free reception may be had from foreign stations or from the local short-wave outlets of our own national broadcast chains, when reception in the standard broadcast band is out of the question.

The next time natural static is particularly severe in the standard broadcast band, try switching to 25 or 31 meters for the reception of a desired program. You need not necessarily know the wavelength of the short-wave station as more than likely you will have no difficulty in recognizing the program in one or the other of these two bands. If the program cannot be found at these wavelengths, try 49 meters, where static disturbances may still be much less severe than in the standard broadcast band.

Selected Programs

MONTHLY bulletins on Selected Radio Programs, which have been distributed free to the listening public for the past year by The Radio Institute of the Audible Arts, have been considerably enhanced by the addition of data on foreign short-wave broadcasting. There are listings of selected programs as well as news broadcasts in English. In addition, there is usually a list of the foreign short-wave stations easily and most satisfactorily tuned in, including the frequencies and schedules.

Requests for these bulletins should be mailed to Pitts Sanborn, Director, The Radio Institute of the Audible Arts, 420 Lexington Ave., New York City.

Local and Distant Stations

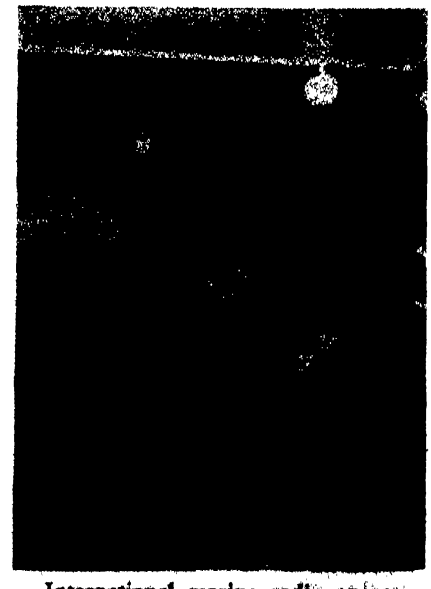
MANY short-wave listeners are curious as to why they find it possible to receive stations thousands of miles distant yet fail in intercepting signals from stations no more than 50 or 100 miles away.

The answer lies in the behavior of radio waves of short length or high frequency. The ground waves—those which follow the curvature of the earth—die out rapidly and seldom can be picked up at a distance of more than 50 miles from the station. The sky waves—those which leave the earth—travel upwards and are reflected back to earth by an ionized layer in the upper atmosphere. The waves can be picked up only at those points where they again strike the earth, which are many miles distant from the station. Between these points no wave is present.

In other words, the radio wave skips over a portion of the earth, and if your receiver is located in this area, the station cannot be heard except under freak conditions. It is for this reason that a listener in New York City may have difficulty in picking up an eastern short-wave broadcasting station, yet find it comparatively easy to pick up signals from stations in Europe, Canada, South America, and so on.

Radio on the "Queen Mary"

RADIO listeners who wish to intercept the radiophone transmissions from the *Queen Mary* during her transatlantic voyages will be disappointed to discover that all 'phone communications other than direct broadcasting are made secret by means of speech-scrambling equipment. This system, similar in effect to the one employed



International marine radio operators in the control room on the *Queen Mary*. The transmitter, 400 feet away, is started or stopped from this room by a dialing system

by the A. T. & T., is employed to insure privacy to subscribers.

However, there is always the possibility of intercepting a broadcast or unscrambled conversation between the ship operators and the shore stations.

The call of the *Queen Mary* is GBTT. To the best of our knowledge, the transmission frequencies employed are as follows: 4100 kc, 4420 kc, 8840 kc, 12,340 kc, 13,330 kc, 16,420 kc, and 17,800 kc. The lower frequencies are employed during the hours of darkness, or during the periods when the ship is a short distance from the shore station, and the higher frequencies are employed during the daytime when the ship is a considerable distance from the shore station.

The Mystic Hand

THE possibility of mis-tuning an all-wave receiver, and the disadvantages of "frequency drift" have been eliminated in a number of the new Crosley all-wave sets by the introduction of "The Mystic Hand"

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which automatically tunes the receiver to the proper place on the dial. Instead of merely indicating the correct place on the dial, the device automatically picks it out. In addition, this feature reduces inter-station noise and compensates for frequency drift of the oscillator circuit.

This system is known technically as automatic frequency control, and is also referred to as "lock-in tuning." It cannot, of course, pick the desired station for you, but once you have at least tuned to the fringe of the desired station, it will automatically take care of any discrepancy that may exist. The listener is therefore insured that the receiver is always accurately tuned to the station being intercepted.

Short-Wave Tuning

IN tuning for short-wave stations, it is essential that the station-selector knob is turned slowly. Tuning for these stations requires the same degree of care and precision of adjustment as you would give the vernier controls on a high-power microscope. The secondary or vernier pointer on the dial scale must be made to traverse the frequency divisions at a very slow rate. If the movement of this pointer is rapid, it is difficult to perceive the presence of short-wave signals. Great care is required in tuning if any but the stronger signals are to be heard.

There are other precautions equally as important; for instance, the dial calibrations of an all-wave receiver are not accurate when the receiver is first turned on. A receiver will "drift" in frequency as much as 20 to 60 kilocycles (2 to 6 megacycles) during the warming-up period and will settle down only after temperature stability is reached, which will take from 10 to 15 minutes at least.

This explains why a station tuned in immediately after the receiver is turned on will slowly fade out, and will be lost altogether unless the receiver is re-tuned to make up for the discrepancy in frequency due to drift. This also explains why a station known to be operating on a certain frequency cannot be heard when the receiver is first turned on if the dial pointer is set to the proper position. In this instance, however, the station will slowly appear if the pointer setting is not disturbed, as the receiver will "drift into proper calibration" as it warms up.

Few all-wave receivers are so accurately calibrated that one can set the dial pointer to the exact frequency of a known station and expect the station to be properly tuned in. It is usually necessary to set the pointer at the approximate frequency of the desired station and carefully rock the station-selector knob back and forth until the station is located.

Seeking unknown stations is an art in itself. Many distant stations are there on the dial scales to be heard, but the majority of them are passed over by the inexperienced listener. The reason for this is simple; since short-wave signals are subject to fading, the listener may well tune through the station during the fade and never be aware of the presence of a station at all. This is almost sure to happen if the signal fades during a period when no program is being broadcast. Under such conditions, the only possible indication of the presence of a station carrier is a very weak hissing noise.

In roving the scales, then, it is important to listen for carrier hiss. The receiver should be carefully tuned for the loudest possible hiss, and left so until broadcasting or station anouncements commence. If the signals are still too weak, stick with them, for in another minute or two they may be so loud that it will be necessary to turn down the volume. There are few stations that cannot be intercepted moderately well when they come out of a fade and reach maximum strength.

Scientific Research Broadcasts

A NEW half-hour radio program sponsored by General Electric popularizes scientific research and makes it easily understandable to the layman. Originating in Rice Hall in the G.E. research laboratory in Schenectady every Saturday night at 7:30 o'clock, Eastern Standard Time, the program is broadcast by WGY in the standard broadcast band and on the short waves by W2XAF. It consists of a popular talk by one of the scientists of the laboratory staff, and a "Science Exchange" through which questions of a scientific nature sent in by radio listeners are answered.

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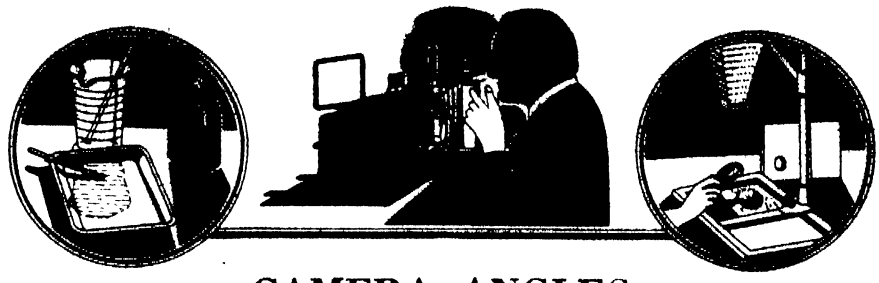

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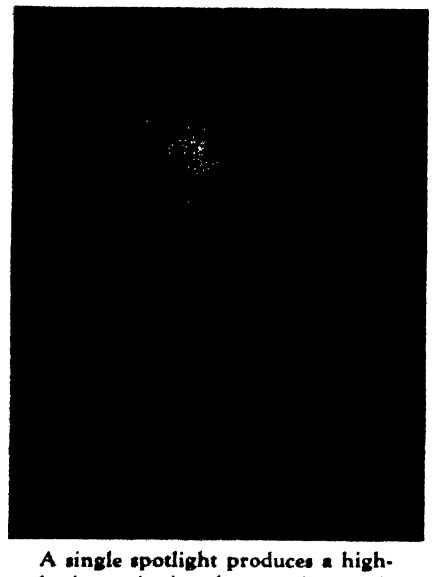
Lighting for Drama

NOW and then someone brings up the exploit of Edward Steichen—today almost a legend in American photographic annals, though a very active camera artist—in photographing a white cup and saucer no less than a thousand times in an effort to plumb the mysteries of photographic lighting. While it is not advocated that all our readers straightway get busy emulating America's photographic ace, the serious worker will understand the spirit that prompted him; namely, the desire to know first and to do afterwards.



A single spotlight produces a highly dramatized and unusual portrait

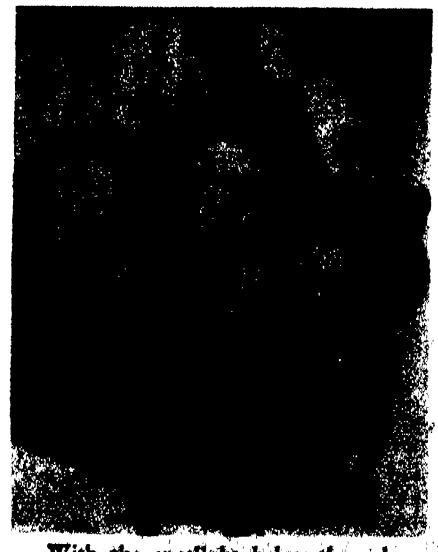
The subject of photographic lighting covers a vast field and deserves the careful study of every earnest camera-hobbyist. In this little discourse, which concerns itself specifically with some of the methods which can be used in lighting for dramatic effects, some inkling will be had of how a little thought and experimentation will give results which can approximate the work of some of the best of today's professionals.

Lighting for drama, as differentiated from straight lighting, involves the use of a concentrated light source to give accent and prominence to some object in order to achieve a striking effect, to give "punch" and forcefulness. A subject which under general illumination would seem lost and insignificant might, if properly lighted by a spotlight, be made to assume an air of great impressiveness. The chief characteristics of a "dramatized" photograph consist of strong, black shadows and equally strong highlights with few if any intermediate tones. Great contrast is the theme. It is the art of black and white in its purest sense.

A floodlight illuminates; a spotlight emphasizes. No attempt at dramatized lighting in photographic work can, therefore, be successful unless we use a spotlight. A combination of general lighting and "spot" lighting has been and can be used in this connection, but it will be found that the most successful results will be obtained by the use of the spotlight alone.

Some versatile workers have made their own spotlights, but if the purse will permit—and it will not be put to too great a strain, since the cost of a good spotlight is quite reasonable—it is best to purchase one and thus take advantage of a product turned out by specialists on the basis of an experienced engineer's designs. Spotlights are available which take either a Photoflood or projection bulb, the latter, for non-professional use, being usually 500 watts. The projection bulb is rated to last about 200 hours. It will give a sharper outline than the Photoflood, although for many purposes the latter may be just as useful. A good spotlight has provision for ventilation, the housing can be adjusted at various angles, the size of the light beam can be varied and the stand is so constructed that the housing can be raised quite high. When lower angles are desired than the height of the stand permits, it will, of course, be necessary either to raise the subject-matter being lighted or to remove the housing from the stand and place it on some lower makeshift support.

Deep shadows are the heart of the "dramatic" photograph, and for this reason the



With the spotlight below the subject, shooting upward at an angle

spotlight is the ideal equipment. It is preferable to use a single "spot" since the use of more than one will involve conflicting shadows; sometimes, however, two "spots" can be used very effectively. Some fine photographs of dancers have been made in this way by directing a low-placed "spot" from each side of the subject, thus casting two separate shadows on the wall.

This type of lighting is found most useful in connection with portraits and still life studies. Some idea of the possibilities

Right: **The full beam of the spotlight was used;** ***below,*** **a rectangular cardboard mask was employed**

will be found in the accompanying illustrations. Simplicity should be the objective; the interest should center on a single point. Study the subject with the light at different angles and take plenty of time to decide when and from what point to shoot.

You are not limited to the shape of the beam thrown by the "spot." You can alter it to suit your particular requirements by cutting a shape out of the center of a piece of cardboard and holding or placing the latter in front of the "spot" lens. Thus, in the case of the decorated vase illustrated above, a rectangular shaped cutout was used.

New Sponges

THE popular Viscose sponges, which were first introduced in two sizes in the shape of a cake of soap, and since then have become available in a more flattened form, are now being put out with a wooden handle. This facilitates handling the sponge in passing its artificial silk, absorbent body over prints and negatives without the possibility of accidentally scratching the emulsion with the finger nails. This "brush-type, scratchless" version is available in small and large sizes.

Agitator for Development

WITH agitation of the tank during development of a roll of miniature film being generally accepted as one of the prime requisites of perfect processing, the appearance on the market of a reasonably priced power driven outfit that will do the job scientifically and steadily should be

welcomed. The "Speedway Agitator," assures uniformity of development and proper fixing, and this without the drudgery of manual agitation.

The agitator oscillates the tank at the rate of 60 times a minute and the manufacturers claim that a "reel immersed in solution advances clockwise as well as oscillates, guaranteeing a continuous flow of the fluid over the film."

Furnished for 110 volts A. C. or D. C., to plug into the ordinary light circuit, the agitator has a fully insulated, encased motor, chrome-plated acid proof tray designed with a pouring lip for over-flow of liquids, and is finished in black with chrome trim.

New Hypo Formula

WHILE retaining the time-honored ratio of 1 ounce of hypo to 4 ounces of water, a new fixing formula for films and plates has been introduced by Eastman under the name F-5. Except for the addition of one half ounce of boric acid crystals and the fact that in mixing, the hypo and the acid hardener chemicals are dissolved successively instead of in the two-formula arrangement called for in the formula F-1, formula F-5 does not differ from its forebear. F-1 is still recommended for developing papers.

ACID HARDENING FIXING BATH
Formula F-5

Water (about 125°F.)	40 ounces
Hypo	16 ounces
Sodium Sulphite, desiccated	1 ounce
Acetic Acid (20%)	3 fluid ounces
Boric Acid, crystals	½ ounce
Potassium Alum	1 ounce
Cold water to make	64 ounces

Avoiding Dust

THE motto "Put Everything Under Cover" may well be adopted by every worker in photography. No one realizes the consequences of not doing so as much as the worker with miniature films, where a tiny speck of lint or dust expands to heroic and extremely disturbing proportions when the negative is enlarged to the sizes found desirable in this field. One precaution to take is to house chemicals and other supplies in a cabinet supplied with a door which can be shut tight. If it is found inconvenient to house developer and fixing solutions in this way, periodical dusting of the bottles will be helpful. For

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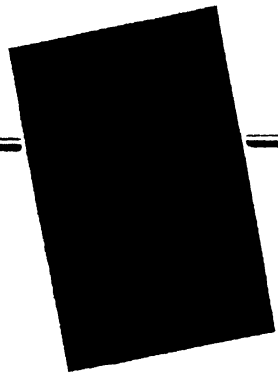

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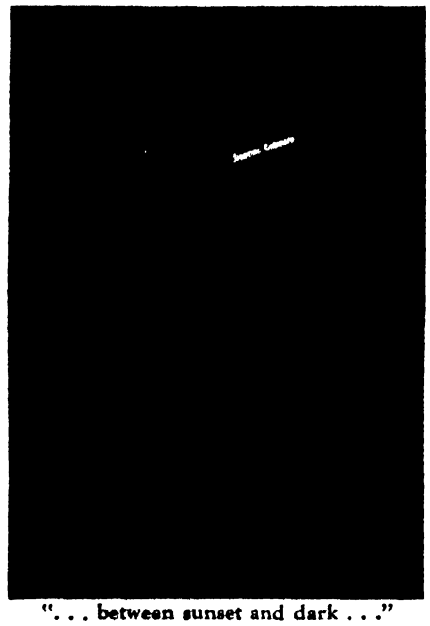
the enlarging camera, which is so susceptible to gathering dust, one good precaution is to make or have made a cloth bag, the opening of which is provided with a draw string. When not in use the machine will be well protected by being covered with such a bag pulled down over the top and the draw string tied at the bottom.

Buildings at Night

THE best time to take pictures of buildings in order to show the outline as well as the lights in the windows is in that brief interval between sunset and dark when there is still some light in the sky, although



". . . between sunset and dark . . ."

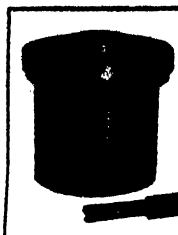
the sun has apparently left for the day. The accompanying picture of the Scientific American Building in New York City was photographed during such a period from the platform of the elevated railway diagonally across Bryant Park. The exposure was one second at the full opening of an F:2 lens in a 35-mm camera. No tripod was used; the camera was kept steady by holding it against a post.

Lighten up the Darkroom

CONTRARY to belief in some quarters, it is not absolutely necessary to paint the walls of a darkroom black. In fact, it will greatly cheer up the place when the room light is turned on if the walls are painted some light color such as a silver gray. Some workers even go the limit and use white paint. So far as working under the safelight goes, this illumination is made more generally effective because of reflection from the walls, which, if painted black, reflect practically nothing.

Philosophic Note

AN amateur with a developing sense of the deeper import of photographic work recently remarked to this department: "You know, the important thing is not being a photographer, but being just an ordinary human being." We who see in our work the means of translating life into pictures will understand this at once. The important thing is not gadgets and formulas,



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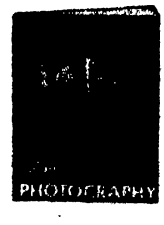

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but the subject matter—the human scene and its varied manifestations—expressed in living, sympathetic terms by means of a camera. Tones are important, composition is important, the right lighting and the correct exposure are important, but more important still is to be "just an ordinary human being." If you do not instinctively like people, if you can't "see a picture" in homely, every-day situations, if the thoughts, the moods, the problems and the way of life of the people you meet do not interest you, then you can be master of every photographic phase and yet be a miserably poor photographer.

Combined Album and Frame

THE spiral binding has been adapted to the snapshot collection in a new type of album which fits into a picture frame, the latter designed to exhibit a page of the album at a time. The album, comprising 20 black leaves with 7 by 9⅝ inches mounting space, is known as the "Snapbook" and fits into the frame, called the "Snapbook Frame." The latter measures 8¼ by 10¼ inches and takes an 8 by 10 inch enlargement; it has a Kodaloid window measuring 6 by 8 inches. The two devices, which are introduced by the Eastman Kodak Company, are sold as a unit.

New album and "Snap-Stickers"

The "Snap-Sticker," a sticker gummed on both sides, thus obviating the use of "art corners," is also announced by Eastman. They are sold in books of 800.

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IN developing bromide enlarging papers in D-72 you may find the prints falling somewhat short of the bright, snappy appearance you would like to have. Instead of using a harder paper, you may increase the contrast by diluting the stock solution in the ratio of 1 ounce of solution to 2 ounces of water, in lieu of the usual bromide ratio of 1 to 4. Still greater contrast may be obtained by a 1 to 1 dilution, although in the latter case it will be necessary to control development somewhat by adding 15 grains of potassium bromide to every 32 ounces of developer.

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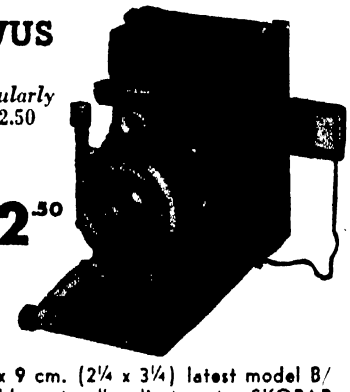

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—among advanced amateur as well as professional photographers—in the type of objectives with which cameras are supplied.

The new Roland miniature has recently made its appearance in the American market, equipped with a Miniature Plasmat lens, designed by Dr. Paul Rudolph who is noted as the inventor of the Tessar and Plasmat lenses and the Kino-Plasmat for motion picture photography.

The Compur shutter of this new camera gives speeds ranging from one second to 1/400. The negative size is 1¾ by 2¼ inches. A desirable feature of the camera is the combination view- and range-finder whereby the field of view and focus are obtained in a single operation.

Mountains From Molehills

SOME time ago this department remarked on the enormous possibilities which lie in the field of re-framing the image in a negative and how a picture which at first glance might seem quite ordinary will, by

Above: **Reproduction from full negative.** ***Below:*** **"Land and Sea and Sky," from the re-framed negative**

careful study and experimentation, yield through the process of recomposing the picture a product that is distinctly worth while and vastly superior to the negative taken as a whole. Also, it has been pointed out that the lack of a telephoto lens does not necessarily always mean that we have to let a good subject go; we can still take the picture and, by enlarging only a part of it, get practically as good a result as could be obtained with the lens of greater focal length. The proof of the pudding is in the enlarging, and in the two examples which illustrate this discourse we have a very fine example of what can be done when the lens will not stretch as far as we want it to.

One of the illustrations is made from the full negative. See how the other has been improved by selecting the real picture contained in the negative and cutting out the rest. Observe how the composition is improved and how the sky is given prominence in "Land and Sea and Sky."

Build a Photographic Library

Leica Manual, *by Willard D. Morgan and Henry M. Lester.* A beautiful book of over 500 pages dealing with all phases of miniature photography. It covers such subjects as panoramas, photomicrography, dental, stage, and aerial photography, photomurals, infra-red, and many others. $4.00.

Practical Amateur Photography, *by William S. Davis.* Deals with the whole subject from the origin and growth of photography to the latest types and uses of cameras. 264 pages, illustrated. $2.40.

Photographic Enlarging, *by Franklin I. Jordan.* A complete treatise on enlarging, discussing not only the necessary equipment but all of the darkroom processing dodges which may be employed, combination printing, mounting, and lantern slides. It is written in a light yet thorough-going manner. $3.70.

Free-Lance Journalism With a Camera, *by Rufus H. Mallinson.* Many serious amateur photographers would like to know how to make money with their cameras; here is a complete guide to that work. It tells not only how to make salable pictures but also how to market them. $1.65.

The Fundamentals of Photography, *by C. E. K. Mees.* Not only tells how to take and finish pictures but gives a solid foundation of the principles of photography. $1.10.

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page 99*)

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Underplanting—Setting out young trees, or sowing seed, under an existing stand.

MOTOR COILS

ELECTRIC motor design has been improved with the discovery that Cellophane used as an insulating wrapping for coils permits the insertion of the same "turns of copper" in less space. It has been proved physically efficient and makes possible a saving of 28 percent in time as compared with motor winding with coils that are insulated with cotton.

HUMAN SKIN THERMOMETER

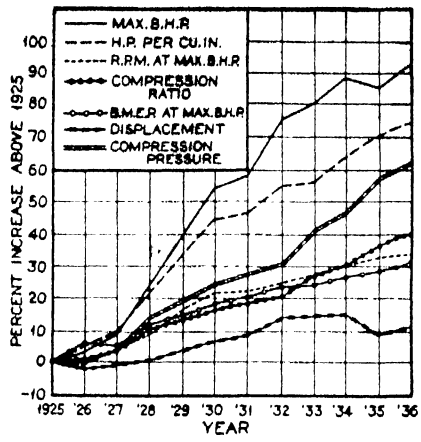
THE much-ridiculed ability of a person to go into a dark room and "feel" that another person—a burglar perhaps—is also present, even though no sound is heard or actual sight is observed, was given scientific credence at the recent meeting of the American Physical Society.

The human skin, reported Drs. J. D. Hardy and T. W. Oppel of Russell Sage Institute of Pathology, New York City, is more sensitive than the best mercury-in-glass thermometers which scientists can make. Five ten-thousandths of a degree, Centigrade, of temperature difference can be detected as a minimum by the skin.

This extremely high heat sensitivity of the skin, said the scientists, "is probably the explanation of the so-called 'sixth' sense whereby the presence of another person in the dark is made known."—Copyright 1936, *Science Service*.

AUTOMOTIVE ENGINES GAIN EFFICIENCY

BETTER fuels for automotive engines have made possible a steady improvement in the efficiency of automobiles during the past decade as shown by the accompanying chart. Since the cost of building engines is closely related to their cost, the fact that power output (Max.B.H.P.= maximum brake horsepower) has increased more than 90 percent since 1925 with an



Gains in automobile engine efficiency

increase of barely over 10 percent in displacement has given us better automobiles at little or no advance in cost. The ability to utilize gasoline of high anti-knock value efficiently through higher compression pressures and greater brake mean effective pressures (B.M.E.P.) has been the crucial point in this development. Without increasing either the size, weight, or cost of the engine, this has effected a large increase in power output. The wide distribution of gasolines of high octane rating at non-premium prices has justified this improvement in engines of all automobiles.—*D.H.K.*

BREEDS BLUE BIRDS WITH YELLOW WINGS

THE objective of thousands of bird fanciers and breeders all over the world has just been reached by E. Anderson, a 21-year-old factory hand of Geelong, Australia. He has produced a blue budgerigar with yellow wings.

Anderson has definitely established the type with three male birds. He intends to perfect the color before placing birds on the market. They may be worth 250 dollars each.

These little Australian parrakeets, known variously as budgerigars, shell parrots, grass parrakeets, and love birds, have been the subject of experiment for years. When the cinnamon winged variety was produced some years ago, its owner made more than 3500 dollars in one year. The new blue variety is a much greater achievement.—*Australian Press Bureau.*

WRONG MAN CREDITED WITH GREGORIAN CALENDAR

THOUGH several American text books on astronomy credit the Jesuit priest Christopher Clavius with having suggested the changes in the calendar which were adopted in 1582 by Pope Gregory XIII to form the Gregorian calendar that we use today, it was another man to whom the honor should go. According to a statement to *Science Service* by Prof. Pio Emanuelli, of the Royal University of Rome, the author of the reform was Luigi Lilio, generally known by the Latin form of his name, Aloysius Lilius. He was a physician of Naples, who lived from 1510 to about 1576. Clavius was a member of the commission which studied the problem, and upon whose recommendation the Pope ordered the changes. He was also a great apologist of the reform, and wrote two important books

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about it. In these he speaks of Lilius in very complimentary terms. NOTE: *Readers may refer to "Our Calendar About Three Hours in Error"—in our June issue—in which erroneous credit was given to Clavius.* —*F. D. M.*

Breeding for Fine Short Staple Cotton

COTTON breeders are now working intently to bring to the cotton field the "blood" of an American Indian cotton that has only one important good quality—exceptionally fine fiber. This new interest in fine fiber is prompted by practical tests that have revealed the new and surprising fact that strength and wearing quality are associated with fine fiber, as much as they are with long fiber.

For generations, cotton growers and spinners have prized Sea Island cotton for its strength. Sea Island cotton fibers were exceptionally long and exceptionally fine. It seems to have been taken for granted that this cotton made strong thread because the individual fibers were long. Dr. R. W. Webb of the Department of Agriculture exploded this belief by the simple method of cutting down the long fibers of some of this cotton until they matched the staple length of ordinary upland cotton, and then spinning and testing thread from the two. Thread from the Sea Island cotton was much the stronger, indicating that strength was more a result of fineness of fiber than of length of fiber.

This discovery by specialists studying utilization of cotton in the Bureau of Agricultural Economics put the cotton production men on the trail of fine-fibered cottons. Cotton breeders in the Bureau of Plant Industry had already experimented with crosses of Sea Island and upland cottons, but Sea Island types do not fit well with boll weevil activities. Dr. T. H. Kearney recalled Hopi cotton, an almost worthless variety of very low yield, grown by the Hopi Indians in northeastern Arizona. About the only desired quality this Hopi cotton had was fineness.

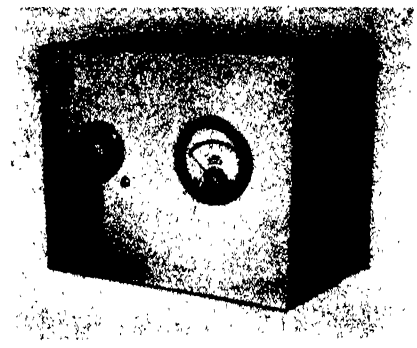
Only a small sample of Hopi was available. Webb and his staff found the fibers remarkably uniform in length, and strong—unexpectedly strong. Webb spun the fibers into thread many times finer than the thread from ordinary cultivated cotton of the same length, and as strong as that from some of the cultivated upland varieties, say around an inch and a quarter staple.

Hopi isn't a market cotton. It yields only a few pounds to the acre, drops many of its bolls, and is generally undesirable, so last year Kearney crossed Hopi with Acala cotton, a good market variety which the Department introduced years ago from southern Mexico. The limited supply of fiber from this cross showed fine qualities in Webb's spinning tests. The staple is uniform and longer than Hopi. The fiber has a silky sheen. And the yarn from the 1⅛-inch staple is estimated to be as strong as yarn from 1½-inch ordinary upland cotton.

From a manufacturing standpoint cotton of the type of this Hopi-Acala cross promises to be particularly desirable. The fiber requires less twist than other fibers of equal length, a quality that helps cut the cost of spinning. The spinner could make finer threads than with ordinary upland cotton, and the spinning costs would be lower than with the longer-stapled Sea Island fibers. The fineness of the thread and its silky sheen offer attractive possibilities for creation of new sheer fabrics of cotton.

Body-Capacity Electric Control

A DEVICE, operating on the principle of body-capacity for the control of automatic doors, alarms, signals, bells, and other apparatus, consists of a single self-contained unit in which is mounted the


No complicated wiring system is needed with this new alarm control

necessary electrical equipment and a relay, together with an antenna which may be from 5 to 50 feet of rubber-covered wire. It is only necessary that a person or car approach within three feet of the antenna to cause the device to operate. This makes it possible to mount the unit itself at almost any convenient place and the antenna run to wherever it is desired the control point to be. The antenna may be run overhead or along a wall any distance up to 50 feet and when a person or car approaches within three feet of any part of the antenna the device will operate the desired control.

This device, known as the Capacitrol, is particularly useful at points where for one reason or another it is not practical to use photo-electric apparatus or where the installation of "treads" is not possible.

Palladium

IT appears that a silvery-white companion for gold leaf has at last been found. It is palladium leaf, now produced commercially in this country and in France. Palladium metal, says the *Industrial Bulletin* of Arthur D. Little, Inc., is of extraordinary malleability, and may be beaten into sheets only 1/250,000 of an inch thick. It takes some 35,000 of these, each 3⅜ inches square, to weigh an ounce. This leaf is tarnish-proof and corrosion-proof and of beautiful color. Either alone, or as contrasting metal with gold leaf, it serves the same purposes, as for book edges, lettering, titling, and the like, and for coating leather to be made into "silver" slippers. Sculptors have used it for covering statuary.

The metal palladium is rare, but is less expensive than platinum or gold. It is found in small amounts in the nickel ore at Sudbury, Ontario, and in isolated places pretty well all over the earth. Palladium is high-melting, strong, and remarkably easily worked, a metal well liked by jewelers and dentists. It makes stronger jewelry than

does white gold. Indeed, it alloys with gold to make a markedly superior white gold, which is highly tarnish-resisting as well as very tough. It alloys well with other metals for special applications. In the chemical industry, palladium is notable for its power of occluding hydrogen, which gives it catalytic properties. A process has been devised for plating palladium to form a highly protective coating for food containers, jewelry, and reflectors, thus extending the utility of this splendid metal.

Developing Latent Finger Prints

TO the Editor: "In the summer of 1932 I had occasion to study the various means of developing latent finger prints. Two methods developed by me at that time have proved exceptionally useful and reliable throughout the past four years. I should like, therefore, to make these methods public through your journal.

"1. One of the difficulties in developing the latent print upon manuscripts, documents, books, and so forth, is that many of the methods employed leave thereon permanent record of the print, or otherwise mar the appearance of the paper. To overcome this difficulty I have employed crystalline iodine with much success. The print may be developed by dusting crystalline iodine over the surface of the paper. This may be photographed with ease but due to the sublimation of the iodine the print disappears entirely within a day or two.

"2. Latent prints occurring upon paper surfaces, such as those mentioned above, may be developed temporarily and then brushed away or made permanent by the use of a powdered silver proteinate such as argyrol or protargol. The process consists simply of dusting the powdered silver protein over the latent print to produce a fine image of a dark brown color. This may be photographed and brushed away or it may be made indelible by the simple process of moistening it with breath blown from the mouth."—*Dudley P. Glick, Assistant Professor, Laboratory of Bacteriology, Colorado Agricultural Experiment Station.*

Level-Wind Casting Reel

A NEW, practical, fool-proof level-wind casting reel has recently been developed by the Spiral Wind Fish Reel Company. It embodies an entirely new level-wind principle and is said to make successful casting easy for the novice as well as the expert caster.

The most noticeable difference between the Spiral Wind and other reels is the spiral shaft over which the line runs, and the absence of the conventional double-thread shaft, pawl, and U-shaped guide.

The rotating spiral arm guides the fishing line smoothly on the reel

The spiral shaft has an oscillating rotary motion forward and back through two thirds of a revolution. The line follows the low point of the spiral back and forth across the spool, insuring a level wind. In casting, the line is free to "bloom" over the spiral shaft without interference. The entire reel is so constructed that all moving parts are protected from dirt and sand. The metals and alloys used have all been selected for strength and resistance to wear and corrosion. The aim has been to design a symmetrically balanced reel with all sharp edges removed so that it feels comfortable to the hand and casts freely.

A New Resin for Improved Lacquers

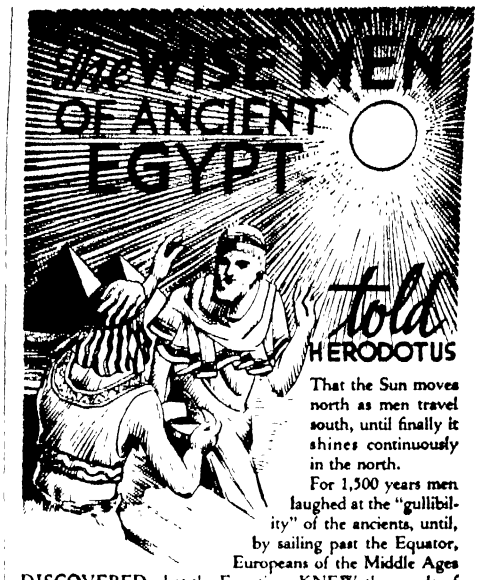
RESINS made by the polymerization of acrylic acid and its derivatives possess properties which make them valuable for use in lacquers to replace nitrocellulose, according to Klein and Pearce, writing in *Industrial and Engineering Chemistry*. Already these resins (marketed under the name "Acryloid") are being used to form the strengthening layer in safety glass with great success, in view of the fact that they do not discolor on prolonged exposure to light. The transparency of the resins, their resistance to water, petroleum solvents, and chemical attack, their strong adhesion to surfaces and their high electrical resistance are valuable in forming protective films from solutions in the customary lacquer solvents. Their use on metals, textiles, paper, and rubber provides valuable protection from destructive agencies. Unlike nitrocellulose, the Acryloid resins do not react with lead and alkaline pigments, and hence the choice of pigments is broader than with ordinary lacquers.—*D.H.K.*

St. Patrick Never Visited This Japanese Island

WHERE did the snakes go when St. Patrick, in the legend, drove them from Ireland? Maybe they came to Ireland's utter opposite, on the other side of the world off the coast of Korea. It is a small island held by Japan, which is so completely infested with poisonous snakes that human beings simply can not stay on the place. Although it would be an ideal site for a lighthouse, the Japanese have left the island to its half million venomous inhabitants, according to *Science Service*.

This island belongs to the province of Kwantung, which, after the Russo-Japanese war, was leased by Japan from China for a term of 99 years. Small-Dragon-Mountain Island, as it is called, lies at the entrance to the Gulf of Pechili, eight nautical miles from the westernmost point of the province of the same name.

In 1931, when an expedition of Japanese scientists was sent to Manchuria to study the natural resources of the country, Mr. Jumpei Sato, the biologist who led the party, was instructed to investigate Small-Dragon-Mountain Island as a possible site for a lighthouse. The investigators, although warned that the island was overrun with venomous snakes, were more than astonished



That the Sun moves north as men travel south, until finally it shines continuously in the north.

For 1,500 years men laughed at the "gullibility" of the ancients, until, by sailing past the Equator, Europeans of the Middle Ages DISCOVERED what the Egyptians KNEW thousands of years before.

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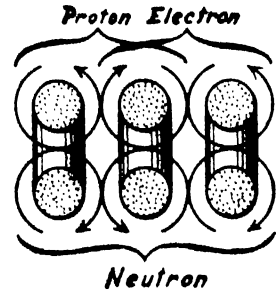

Official science, finding itself unable to produce any satisfactory picture or diagram of the atom under its erroneous nuclear theory, is now trying to tell the public that this quagmire of indeterminism, i. e. "the new order of things," is really a commendable step in advance. The author, however, prefers diagrammatic illustrations, and it will be seen that under the new vortex system the atom *can* be represented diagrammatically.

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at the snakes' paradise which they discovered.

The snakes belong to a species of moccasin not found in Japan. They are not swift in attacking human beings, preferring rather to escape. They are so numerous that it is impossible for a person to walk even a few feet without encountering them, and they are easily captured by means of a forked stick. The island lies in the path of the migratory birds of Manchuria; and in migrating seasons those birds which stay their flight to rest here are devoured by the snakes, which wind their coils around the branches of bush and tree and wait for their prey. When quail or siskin or swallow are not to be had, these snakes live upon wild soybeans, maize, arrowroot, mugwort, and so on.

While one member of the party was taking moving pictures of the snakes, another suggested that the only way to rid the island of them would be by burning off the brush. But this suggestion was quickly set aside, because of the Chinese respect for the snake as the "little one" of the serpent family, the "big one" being the dragon, the Chinese national emblem. This sacred relationship makes some claim for government protection. Still another reason for protection is that the snake is—and has been for thousands of years—the source, the raw material, from which potent medicines have been made in China and throughout the Orient; and it would be an insult to Nature's bounty to destroy wantonly such a valuable supply, where the reptiles are so easily caught without danger to the catcher.

Dr. Shuji Hassegawa, M.D., director of the Bacteriological Institute of the Government Dental College in Tokyo, a member of the expedition, made a report concerning this island to the Biological Club of Nippon. He stated that the scientists who made the investigation have recommended to the government that Small-Dragon-Mountain Island be set aside as a permanent paradise for the rare snake species.

Poorly Taught Students

SCIENCE and mathematics professors in the colleges now regard the present crops of high school graduates as inferior in basic training to those students who entered college only 10 years ago. This is the unfortunate result of a recent trend in education wherein more stress is placed on the mechanics of teaching than upon knowledge of the subject matter. "Teaching I-II" and "The Psychology of Teaching" are stronger qualifications nowadays for a high school instructor's position than are, for example, "Advanced English," or graduate courses in the sciences. Because of this, many college professors could not qualify to teach in some high schools.

These facts have been brought out by a committee of the American Chemical Society who charge that the "professional teacher training" group among educators has secured a monopoly of the education machinery. In addition to the above facts the committee adds that the situation is tending toward a worse condition.

In selecting high school teachers, the committee charges, a premium has been placed on applicants who are more interested in *how to teach* chemistry, for example, than those who *know* the most chemistry. Moreover, *Science Service* reports the committee as saying that the unrestricted certification of individuals to act as high school instructors permits teachers to give instruction in fields in which they are untrained. In an understaffed high school, such broad certificates permit the biology teacher to give instruction also in chemistry, physics, mathematics, or in French or German for that matter.

"In a majority of the states," the committee finds, "the training of teachers and their recommendation for certification to the State Board of Education has been delegated by law, or other authority, to teachers' colleges and colleges of education, and in extreme instances only those persons who have been registered students in such colleges are eligible to certification.

"By this method the 'professional teacher training' group has secured a monopoly of the educational 'machinery' and in many states the fundamental subject matter departments of the universities have been legislated into a position where no member of their faculties has any voice in setting up curricula and requirements to be met by prospective teachers."

PERMANENT LICENSE PLATES

OF the several states that have adopted permanent license plates for automobiles, Connecticut is the first to use aluminum. Each owner retains his same number year after year, starting in 1937, only inserting a small year plate in a cut out section of the larger one.

10,000 Unpaid Volunteers

A COMPLETE picture of North American climate is possible only because of the great mass of fundamental facts furnished by 5000 volunteer weather observers. Each unofficial observer, says W. R. Gregg, Chief of the Weather Bureau, really runs a small field station, at no expense to the government, except for the few instruments and blank forms used.

This system of augmenting official weather records began in 1891, when the newly created Weather Bureau was charged with the duty of "taking such meteorological observations as may be necessary to establish and record climatic conditions in the United States." The cost of maintaining thousands of stations to make these observations all over the country was prohibitive.

About 300 members of the present volunteer force have served for 25 years or longer. Three have been keeping records for more than 50 years and 54 for between 40 and 50 years. There are 300 women observers, three with more than 40 years of service. To prevent breaks in the continuity of the daily records, each observer has a substitute, which means that 10,000 persons are ready to give their services at any time.

Every day at a fixed time—usually around sunset—the observer records the maximum and minimum temperature, the precipitation, and such unusual conditions as wind, dust, or thunderstorms, fog, and frost. At the end of the month the record goes to the Weather Bureau in Washington, D. C., for tabulation and filing.

From millions of these records, meteorologists work out the answers to countless questions on climatology. Recently these questions have dealt largely with land policies, for land is "conditioned by the sky under which it lies and by the climate which is proper to it."

Some Perfumes Help, Others Harm Plants

PLANTS are aided in their growth by certain odors, harmed by others, reports Dr. Madaus, of the staff of the Radebeul Biological Station, near Dresden. Seedlings of rye, lupines, and cress grew much more rapidly when exposed to the scent of ripe apples. The odor of peppermint, on the contrary, had a marked depressing effect.—*Science Service.*

FRANKFURTER ROLLS

IF the makers of a new machine have their way, visitors to resorts and amusement parks this summer will see their rolls and frankfurters baked together before their eyes. This new machine, electrically operated, actually bakes a roll around the frankfurter.

Science Lays a Ghost

GHOSTS in the spectral line photographs of elements are false lines appearing on each side of the real lines, and are caused by imperfections in the way the rulings of grooves in a diffraction grating are made. A grating consists of thousands of tiny parallel slots cut in glass or metal, which have the property of spreading out light rays into the various colors or wavelengths. Thirty thousand lines to the inch is sometimes attained in the ruling, which is done automatically with a diamond point. If the lines are not exactly parallel the ghosts arise.

With the aid of an improved technique for making diffraction gratings, Dr. R. W. Wood of Johns Hopkins University recently pointed out, the ghost effects have been reduced so that a ghost line will have only 1/1200 of the intensity of the nearby "real" line. While the ghost is not killed, perhaps, it is certainly true that it is very much weakened.

The trouble with making ruled gratings on glass or spectral metal, Dr. Wood indicated, is that the diamond point may break or at least become worn before the 180,000 lines in a six-inch grating can be finished. In his new method, Dr. Wood first coats Pyrex glass with a layer of chromium only a few molecules thick, and then puts on an additional layer of aluminum which is much softer. The chromium and aluminum are evaporated on by the methods used at California Institute of Technology by Dr. John Strong. The ruling of the grating is then performed on the soft aluminum, with improved results.

For making glass gratings, aluminum is put on the glass and scratched with the ruling diamond point. Then the surface is dipped in powerful hydrofluoric acid which eats away at the exposed glass surface and at the ridges of aluminum. Quickly, however, the grating is removed from the acid and when the aluminum is washed off it is found that little grooves have been etched in the glass. These parallel grooves are what give the grating its diffracting property.

As before, improvement comes because the actual cutting by the ruling machine is done on a layer of aluminum instead of the glass surface.—*Science Service.*

Saving 8000 Mothers

THE Maternity Center Association in New York points out that medical science could save a large proportion of the mothers who die in child-birth. These deaths are, therefore, called needless. Yet, year after year, the death rate among mothers in the United States has remained nearly stationary. People are shocked to be reminded that the United States has one of the highest death rates for mothers in child-birth of any nation.

It is sometimes argued that conditions are not so bad—that it is merely different ways of keeping statistics that make the United States deaths loom so large. But this alibi is shaken, according to *Science Service*, now that a study of the United States Children's Bureau has declared: "No matter what method of procedure is used, the United States retains an exceedingly high rate as compared with other countries."

The traffic deaths that get newspaper headlines and seem so extravagantly frequent, add up in a year to 36,400 dead. Maternal deaths total almost half that number, adding to 15,000, of which over half are pronounced preventable.

The thought that the Maternity Center Association is driving home is that prospective mothers should make every effort to get adequate care. It is a vital matter. Those who do not know where to turn for adequate care can get information from social and health agencies regarding clinics and medical centers.

The six-fold program of the Association, to prevent the preventable deaths, narrows down to these brief items:

1. A complete medical examination early in pregnancy.
2. Regular and frequent medical supervision of prospective mothers.
3. An aseptic delivery under the supervision of an obstetrician.
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killed and cut into small pieces, minced insects of other kinds, bread, crackers, hard boiled eggs, any kind of vegetable, any kind of unsalted meat, milk of all kinds—sweet, sour, evaporated, buttermilk, malted milk—all these the bats fed and thrived on.

They preferred cottage cheese above other artificial foods, Prof. Gates said, and would even drop other foods they had already picked up, if they found it available. Their preference for bees rather than other insects might appear strange at first, for bats fly at night and bees by day, so that they do not normally meet. However, Prof. Gates suggested, the nectar carried by the bees may have given them an attractively sweetish taste.

All the food had to be chopped up very fine, for bats are rather helpless, with both arms and legs involved in their wide "leathern" wings, and their mouths are adapted only to the intake of very tiny morsels. Their meals must be served in very shallow dishes, as must also the necessary supply of drinking water.—Copyright 1936, by *Science Service.*

Just Like the Rest of Us

CHIMPANZEE society has both its liberal givers and its chronic beggars, to judge from a study of food-sharing behavior reported by Dr. H. W. Nissen and Dr. M. P. Crawford of the Yale University Psychology Laboratories. Some chimpanzees will never beg food of another; others will beg whether or not they have food of their own at hand. Some never respond to a plea for alms, and others, even though they are the strongest of the group, will give voluntarily.

The experiment was designed to determine whether chimpanzees ever share their food under conditions of non-compulsion, and when no direct or immediate gain for the animal who shares is involved. Eight chimpanzees were observed in different combinations of two during 90 experimental periods. Two subjects were placed in the same cage or in adjoining cages separated only by iron bars. One or both were given food. One of the most striking results when the animals were in the same cage was the discovery that the most dominant individual, that is, the most aggressive and usually the larger and stronger, did not always get the major portion of food, even though he could have had all.

Teasing behavior was common among the animals. Some enjoyed offering food through the bars to a begging companion and withdrawing it quickly just before it could be grasped. Some individuals begged food, placed it out of reach in their own cage, and immediately begged for more.

Three-Meter Facsimile Service

ON June 10th, radio communication hailed the approach of new services by which business men will send one another entire letters by radio instead of terse 10-word telegrams and in which social notes will speed through space to be received and delivered in the exact handwriting of the senders. The occasion was the first demonstration of RCA's new ultra-short wave radio circuit connecting New York and Philadelphia. The circuit is unique in that it employs ultra-short radio waves with automatic relay stations and makes possible the transmission of drawings, type matter, handwriting, and other visual material in facsimile, along with the simultaneous operation of automatic typewriter and telegraph channels. It is a completely secret system.

The automatic repeater stations, which catch the radio waves speeding in both directions and relay them to their destinations at New York and Philadelphia, are located 30 and 66 miles respectively from New York. Since the range of three-meter radio waves is virtually limited to line-of-sight, the points of reception and transmission for each of the stations were selected to provide the most distant optical horizon. In New York and Philadelphia, therefore, the antennas are located atop tall office buildings.

Each of the repeater stations employs two different transmitting wavelengths, or one for each direction. The two terminal stations each use one sending wave, making a total of six wavelengths, or frequencies, for the complete circuit. If it should be desired to extend the circuit beyond either terminal point, these six wavelengths could be used over and over again in the same sequence, without creating interference, and so a single circuit could be extended from coast to coast.—*M. L. M.*

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

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KNOW YOUR ROPES is a complete reference manual for users of wire rope and for engineers. It contains useful data in tables and text on how to make wire rope last longer. It also points out many of the troubles that can ensue from the improper handling of such cables. *Write for Bulletin 836B to Scientific American, 24 West 40th Street, New York City.—3 cents.*

187 BOAT BUILDERS is a large folded sheet, giving a complete boat buyer's directory of the products of leading boat manufacturers. *Write for Bulletin 836A to Scientific American, 24 West 40th Street, New York City.—3 cents.*

SELECTION OF LUMBER FOR FARM AND HOME BUILDING, by C. V. Sweet and R. P. A. Johnson, emphasizes the correct choice of wood as a money-saving factor

in building construction. The bulletin also points out the efficient construction principles, including proper roof drainage, adequate ventilation, and solid connections between superstructure and foundation. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

LOOKING FORWARD is a pamphlet dedicated to the prevention of blindness. It tells of propaganda activities directed toward this end, particularly by communities, schools, and industries. *National Society for the Prevention of Blindness, Inc., 50 West 50th Street, New York City.—Gratis.*

ASPHALT, by J. E. Pennybacker. The possible uses of asphalt are far greater than the most familiar one of paving roads. It can be used for roofs, on tennis courts and floors, in the plastic arts, for anti-corrosion purposes, and so on. This booklet, illustrated with unusual woodcuts, presents both the historical background and present day applications of the material. *The Asphalt Institute, 801 Second Avenue, New York City.—Gratis.*

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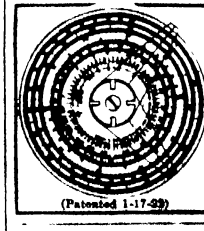

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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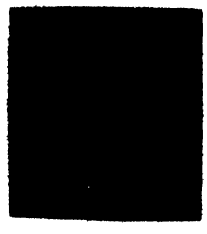

THIS month's cover is a striking example of amateur photography under adverse conditions. There have been hundreds of negatives exposed in an attempt to capture the beauty of lightning; but this one, by J. M. Stofan, winner of the Third Prize in our Photographic Contest announced on page 136, is certainly the finest we have ever seen.

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50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of September, 1886)

SODA LOCOMOTIVES—"At the Baldwin Locomotive Works there are in course of construction four locomotives, which are designed to be run by soda, which takes the place of fire under the boiler. . . . The boiler is of copper, 84½ in. in diameter and 15 ft. long, having tubes running through it as in steam boilers. Inside the boiler will be placed five tons of soda, which, upon being dampened by a jet of steam, produces an intense heat."

RAMESES II.—"One of the most remarkable and interesting events pertaining to Egyptology was the recent unrolling of the mummy of the ancient monarch, Rameses II., under whose reign the flight of the Jews led by Moses occurred. . . . The legs and thighs are fleshless; the feet are long, slender, somewhat flat soled, and dyed, like the hands, with henna. The corpse is that of an old man, but of a vigorous and robust old man. We know, indeed, that Rameses II. reigned for 67 years, and that he must have been nearly 100 years old when he died."

INCLINED RAILWAY—"Messrs. D. H. & G. Haggie, Wearmouth Rope Works, Sunderland, are manufacturing two long ropes for a tramway which is in course of construction at Hong Kong, from the town up to 'The Peak.' . . . The incline where the ropes have to work is 4,800 feet long, laid with 35 lb. steel rails on steel sleepers, the line being partly single and partly double; the gradients varying between 1 in 2 and 1 in 10, following closely the natural contour of the ground. The total height the carriages have to be raised is 1,300 feet. The ropes run on separate sets of friction rollers, the one a working rope and the other a safety rope."

MEXICAN RAILROADS—"The expenses of railroading in this hot climate are great. Wooden ties have but a short life, cracking in the dry season, and rotting during the rainy months; bridge timbers and piles also wear out rapidly. Freight cars must be painted frequently to prevent drying and cracking, and even the substantial Pullman cars shrivel under this exposure."

IRON SHIPS—"The opening of the new line of mail steamers by the North German Lloyds, of Berlin, has attracted much attention. . . . The first of the three larger vessels . . . was launched with much ceremony on July 10, and was christened *Preussen*. . . . Length at the water line, about 388 ft.; beam, 44 ft.; and depth from keel to the side of the upper deck, about 33 ft.; cubic contents, 4,000 tons; draught, 20 ft.; and speed 14 knots, or 16 miles an hour. The engine is a three-cylinder expansion engine of 3,500 horse power. . . . The hull of the vessel is made of Martin steel."

UNDERGROUND CABLES—"At the recent convention of the National Electric Light Association, no little time was occupied in a discussion of the expediency of burying the wires. The sense of the convention was decidedly opposed to the project at the present time. Continued experiment and study, while they have done much to remove obstacles, have not yet resulted in finding a solution."

ELECTRIC BOAT—"The *Spark*, which has recently been launched at the Royal Gunpowder Factory, Waltham Abbey, is an electric boat about 25 ft. long and 5 ft. beam. It was designed by the superintendent, Col. W. H. Noble, R. A., mainly as a means of lighting some of the powder houses in the factory, which are at a considerable distance from the dynamos used for general electric lighting purposes."

SALT MOUNTAIN—"Palestine possesses a remarkable salt mountain situated at the south end of the Dead Sea. The length of this ridge is six miles, with an average width of three-quarters of a mile, and the height is not far from 600 feet. There are places where the overlying earthy deposits are many feet in thickness, but the mass of the mountain is composed of solid rock salt, some of which is as clear as crystal."

UMBRELLAS—"Umbrellas, when wet, should be placed with the handle downward to drain. The moisture thus concentrates at the tips and falls from the edge, instead of gathering into the folds of the umbrella, and thus dries quicker and the fabric is better preserved."

RACING YACHTS—"The International Queen's Cup, won thirty-five years ago by the schooner yacht *America*, has again, after so long a sojourn in this country, become a subject of contest. The *Galatea*, an English keel boat, having had her challenge of 1885 extended so as to allow of her racing under it this year, has met the American centerboard yacht *Mayflower* for a series of inside and outside course races to decide the future holding of the trophy. . . . In the *Galatea's* model will be recognized the convex lines of the conventional cutter. Her sheer is quite pronounced, an end elevation of the hull showing a sharp rise in the bow that is missing in the *Mayflower*."

BLONDES—"The use of peroxide of hydrogen, commonly called oxygenated water, is extending for bleaching purposes. It will be remembered that some years ago the fair sex rendered this product somewhat popular by partially bleaching their hair with it, but the product has now emerged from this fashionable employment into the more common and perhaps more useful application for industrial purposes, being now employed for the bleaching of feathers and also of tussah silks, for which it is admirably adapted."

TREE GRAVES—"Mr. John J. Campbell, of Rockville, Ind., has succeeded in the very original work of tracing the course of a cyclone which must have passed over that portion of the country more than 300 years ago. The course of the storm was traced by means of what he calls 'tree graves'—that is, the little mounds which a tree makes when it is uprooted and allowed to decay upon the spot upon which it fell. The earth thus turned up by the roots, with the decayed root itself, will form quite a large mound."

AND NOW FOR THE FUTURE

¶Secretary of Commerce Daniel C. Roper, on the Future of the United States Merchant Marine

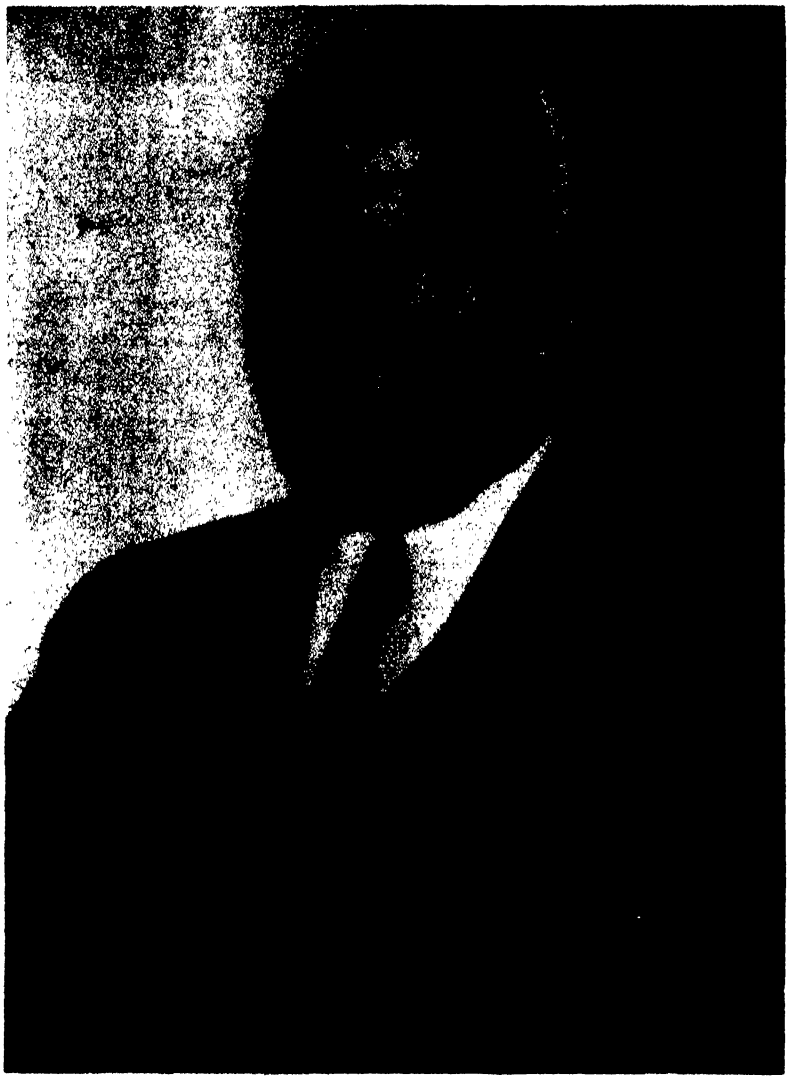
¶"The Mists of Madness," by Prof. H. Estabrooks

¶Science versus Magic—Modern Prospecting for Oil, by Aubrey D. McFadyen

¶The Intriguing Story Behind Launching Big Ships, by Commander W. M. Angas

¶Triborough Bridge—Striking Photographs of this Engineering Marvel

Personalities in Science



FRANK RATTRAY LILLIE

AT its most recent meeting, held in its own splendid headquarters near the Lincoln Memorial in Washington, the National Academy of Sciences, premier body of American men of science, chose as its president for the next four years Dr. Frank R. Lillie of the University of Chicago. The National Academy of Sciences—a name which many a newspaper proofreader with the best of intentions has changed to an incorrect form, The National Academy of Science—is the "Royal Society" of American science, its members being chosen with great care by the Academy members themselves because of definite eminence and accomplishments in some one of the several sciences. In turn, only pre-eminent scientific men have been chosen president of this carefully selected body of less than 300 members: Joseph Henry the great physicist, Agassiz the naturalist and geologist, Remsen the chemist, Welch the pathologist, Walcott the paleontologist, Michelson the physicist, Morgan the geneticist, Campbell the astronomer, the last-named of whom Dr. Lillie succeeds.

Dr. Lillie was born in Toronto and educated at the University of Toronto, Clark University, and the University of Chicago. At the University of Chicago he is professor of embryology and dean of the division of biology. He is also managing editor of the *Biological Bulletin* and editor of the *Journal of Experimental Zoology*. He specializes in such research as the early history and fertilization of the ovum, the physiology of development, heredity, and the biology of sex.

Recent comment on Dr. Lillie's career, written by Dr. Frank Thone, biological staff member of *Science Service*, throws it into clear relief:

"Modern educational and research institutions are run by professors. Professors are often referred to as impractical dreamers, incapable of handling anything with real money involved. But size up a marine biological laboratory, or even a single teaching and research department in a first-class American university, and you find yourself face to face with the equivalent of a million-dollar corporation, with executive responsibilities as exacting and administrative problems even more complex. A man who can run one of those things need not take a back seat to any so-called captain of industry.

"Such a captain of science is Dr. Frank Rattray Lillie, who holds down two jobs either of which might easily floor many a man who patronizes professors. He is dean of the division of biological sciences at the University of Chicago, which also involves being chairman of the department of zoology and professor of embryology; he has held the latter chair since 1907. He is also president of the Marine Biological Laboratory at Woods Hole, Massachusetts, and of the associated organization, the Woods Hole Oceanographic Institution.

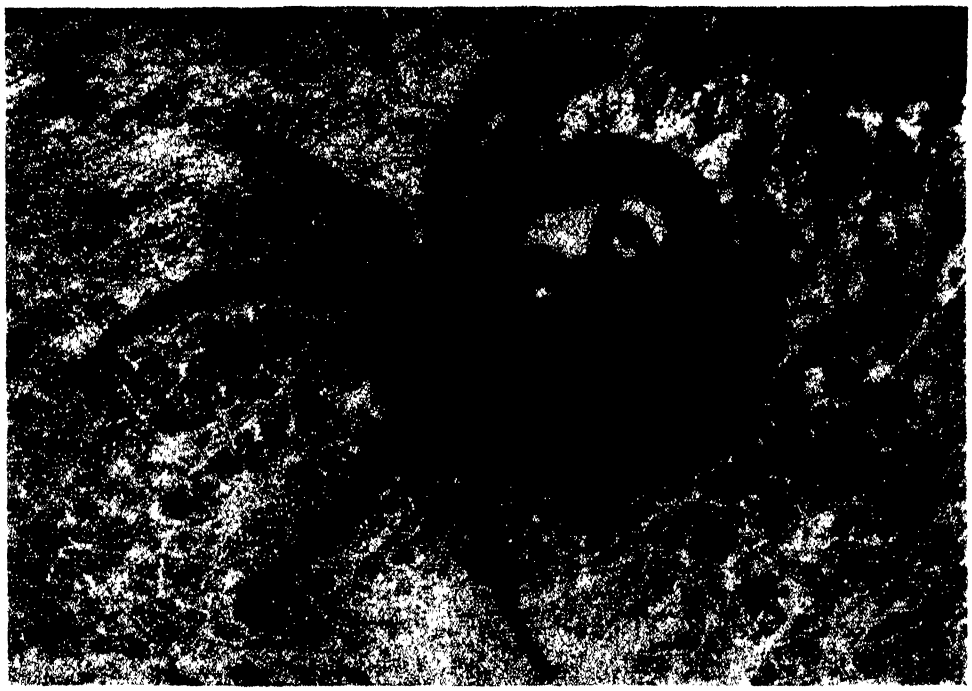
"But being executive head of these knowledge-factories has not stopped him from working at his trade. He has been able, all these years, to go out into the shop and do a lot of straight, solid creditable bench work. His researches in the biology of reproduction have brought him especial fame.

"Added to all this, he has been able to carry on scientific publication notable in its extent. Papers and books based on his own research almost beyond counting, and editorship of two important biological journals are the records of his activity in this field.

"His work has received its due recognition, in memberships and offices in the leading American and foreign science societies, notably The National Academy of Sciences."

THE BLACK WIDOW'S MATE IS INSIGNIFICANT

THE Black Widow spider, after the male has served his purpose, is soon a widow in truth, *his* life being relatively short. Here he is shown in comparison with an ordinary house fly. But the female spreads over as much as two inches, with a jet black body three- to five-eighths inch long. The characteristic hour glass pattern of both sexes shows plainly on the abdomen. These spiders are not new, the Indians having known them and called them "pokomoo," but they are clearly increasing in numbers at present.



A large female Black Widow shown slightly over double size. The hind legs carry a kind of "comb" with which silk in almost liquid state is thrown as a lasso on the victims. Two of the Widow's eight eyes show silvery in the photograph. In the June number of *The Quarterly Review of Biology* there was a detailed, 37-page article on the Black Widow, by D'Amour, Becker and Van Riper of the University of Denver. Squibb and Sons are developing serum

CALLING ON THE WIDOW

Our Most Poisonous Spider . . . Incredible Speed . . . Throws Her Lasso . . . The Death Blow . . . But the Male Doesn't Amount to Much . . . Antitoxic Serums

By NELSON WM. BAKER
Santa Barbara, California

THE beam from my flashlamp cut into a dark corner of the woodshed, exposing an unlovely network of spider web, crossed and criss-crossed from splinter to splinter, and converging around the miniature cavern of a knot hole. So this was the dreaded lady's den—the home of our most poisonous spider, the Black Widow, scientifically speaking, *Latrodectus mactans*. I had caught a brief glimpse of her shiny-black, button-like body disappearing into the knot hole that afternoon when I went for wood, and now I had come to make a formal call.

Her ladyship was nowhere in sight, but, as I had every reason to believe that she was at home, I reached forward and "knocked" gently by lightly vibrating a strand of her web with my finger. After repeating this several times, I was rewarded by the appearance of two spindly, black legs protruding from the knot hole. As the web-shaking continued, the Widow crept farther and farther from her lair, until soon she was in full view, her black abdomen reflecting, mirror-like, the light from my flashlamp.

She descended to my very finger tip, swung sharply about and, with her long, hind legs, lashed out thick, glistening shreds of webbing, which clung to my finger like glue. Evidently feeling certain that she had ensnared whatever luckless creature had wandered into her net, she turned abruptly to nip the victim and stop its struggles with her powerful potion. At this point I jerked my finger away, tearing both the web and its occupant away with it. Soon thereafter I carried the captured spider to my desk in a glass jar.

THIS was a very different home from the one she had been accustomed to. She crawled for a while around the circular glass wall, feeling here and there with her delicate palpae, and trying to find a place to hide away from the glare. Her silvery sparks of eyes caught the light occasionally, and made me feel that she was staring at me—although I knew she could barely see at all. Soon she began to attach little web-anchors about the bottom of the jar, drawing a silken strand from one spot to another until she had spun a soft carpet that protected her body from the cold glass. Then, after many attempts, she anchored a cable up on the side of the jar, and from then on she busied herself manufacturing a crude web that extended halfway to the top of her prison. This new web was fresh and shining, although of the same crazy, criss-cross design as the coarse, dirty web she had swung on in the woodshed. Many times, as she was spinning, I got a good view of her characteristic marking—a crimson "hour-glass" on the under part of the abdomen. (Opposite page.)

Experimenting, I placed a book beside the jar, in such a position as to shut out most of the light. Apparently able to see better, she cleaned and moistened her feet by putting each one to her mouth and nibbling at it, then went over her spinning work carefully, finding and mending all flaws. Repairing done, she began endless attempts to extend her web to the top of the jar.

In the morning I found the spider in the lid of the jar, evidently waiting for breakfast. I captured a lively Jerusalem cricket and dropped it into her web. His powerful, armored legs tore the strands, almost pulling the Widow from her perch. She seemed little excited, however, and just moved her long, fore legs sharply. The cricket, in his wild dashes around the jar, vibrated the web more and more, until the Widow suddenly began to move a little

in his direction. When the bulky insect caught a leg in a mass of tangled webbing and jerked mightily, the spider rushed to the scene of disturbance, but arrived too late, for the cricket had escaped. It seemed that she could not locate the cricket by sight, but only by the "feel" of her web, for she could easily have intercepted the insect many times had she been able to see it. Each time she arrived at a spot where the cricket had been momentarily caught, she spun about and lashed out webbing frantically, endeavoring to secure the intruder. However sluggish *Latrodectus* is reputed to be, she can move with incredible speed when aroused—short, jerky rushes, which must be very confusing to pursued insects.

During one of these rushes the spider turned and, purely by accident, I believe, threw strands of her viscous web over the cricket's fore legs. Struggle as he would, he could not break that gummy mass of strong cables, and each second of delay on his part was proving his undoing, for the spider was rapidly entwining him.

When she had finished her job, the cricket could barely move. She rested a moment before the "death blow," which was merely a nip or two from her diminutive, needle-sharp fangs. A few minutes after these "injections" the cricket ceased to move, except for what appeared to be convulsive gasps for breath.

If I dropped an insect into the jar at night when the light was very dim, she would go at once to the victim and deliberately wrap it with webbing. If the prey did not become entangled, and walked about the bottom of the jar, the spider would follow with short, jerky movements until she was within reach, when she would whirl about and, with deadly accuracy, throw her lasso.

ON one occasion I dropped a dozen large flies into the jar at once. The result was more or less amusing, as far as the spider was concerned. She rushed from one fly to another, spinning about and hurling her silken lariat in their general direction. No sooner had she caught one, and was preparing to give it her attention, than another would cause lively commotion elsewhere. She couldn't resist these distractions, and would hurry from one to another, apparently consumed by the greatest anxiety lest the insect she had just left should escape. Before long she had captured and nipped all the buzzing pests. I tried to check as nearly as possible the time, from the moment each fly was bitten until it ceased to move, and found it to vary from 40 seconds to two minutes—a fast worker.

The tiny, white poison gland that lies along each side of the Black Widow's combined head and thorax secretes an extremely powerful, neurotoxic poison, which is considered more potent, drop for drop, than the venom of any of the world's most deadly reptiles. If you take into account the fact that the venom of the great king cobra of India is said to have killed elephants, it is small wonder, then, that the bite of the Black Widow has violent effects on man. Should this diminutive spider inject the same quantity of poison as the cobra it would doubtless mean almost instant death to the victim.

Black Widow venom seems rapidly to paralyze the rear legs and abdomen of bitten insects. Innumerable small moths that I pricked with a very sharp needle dipped in the solution from crushed Black Widow poison-sacs and then released, flew about for a few moments, dropped to the floor, and ran about dragging their rearmost legs. Naturally, my crude apparatus was not nearly so effective as the spider's, and the amount of venom introduced much less, but in nearly all instances the moths died in varying lengths of time. Rats and mice die in convulsions shortly after being bitten, showing marked symptoms of paralysis of the abdomen, lower extremities, and respiratory organs.

The effects of the poison on man seem to vary slightly. From the persons I have talked with, who have been victims of Black Widow bite, I have received two different stories as to the "feel" of the bite itself. Some say they felt no immediate pain at the time; others seem to shudder at the recollection of the electrifying sharpness of the pain they experienced when bitten. There is no doubt, however, as to the seriousness of the symptoms, for all were in deadly earnest when they told of the various stages of suffering that followed the bite. These may be summed up briefly as: muscle pain, general weakness, numbness, and profuse perspiration; high blood pressure, slow, weak pulse, paralysis of the lower extremities, and rapid, labored breathing. The protein poison of *Latrodectus* seems quickly to attack the peripheral nerves and nerve ends, and to travel through them to the lymphatic glands and thence over the entire nervous system. The effects of the venom on the phrenic nerve sometimes cause almost complete paralysis of the respiratory organs, and if this persists, death is often the result.

A female Black Widow spider guarding her two egg sacs, which show above and to the right of her

A FISHERMAN, who was recently bitten by a spider while in fishing camp on Santa Cruz Island, ended up in a Santa Barbara hospital, where he was kept for five days, while efforts were made to check his pain and convulsions. One side of his body was completely paralyzed, and he had to gasp in order to get his breath. On talking with him after the ordeal, I learned that he had received the bite just as he was preparing to "bunk in" beside his camp-fire. The spider, which he afterward killed, bit him just below the knee, and he told me it felt as if some one had poured gasoline or alcohol on his leg. He said there was first a cold, then a burning sensation, which spread rapidly, causing him great pain in groin and abdomen within 15 or 20 minutes. The following two or three hours he thought were his last, but he managed to get some relief by applying heated stones to his abdomen and drinking hot, salt water. The rest of the party were finally able to get him to the boat and start for the mainland, where he was immediately rushed to a hospital. As I was leaving him after our talk, he added with great fervor, "—and, boy, I'd rather do anything than go through that again."

It has been only within the last year or two that scientists have really taken much interest in the Black Widow. Since 1921 the Los Angeles General Hospital has, however, made the most of its *Latrodectus* bite cases by requesting the convalescing patient to return in a week or so to give up some of his infected blood, from which the chemists extracted the solids and made an apparently effective antitoxic serum. For some time this was the only serum available, and but little of it was to be had, as Black Widow bite victims were few—at least those that had hospital treatment.

Lately, several new and more effective methods of fighting the ravages of this little, black spider's poison have been discovered. Dr. F. E. D'Amour, a Denver physiological chemist, has developed an anti-toxic serum from the blood of rats which have been immunized by repeated injections of minute doses of *Latrodectus* venom. As little as

two drops of this serum is said to counteract eight times as much poison. Other treatments successfully used are intravenous injections of magnesium sulfate, or calcium glucinate.

In the last few years climatic conditions in certain parts of the country have so favored the Black Widow that it has become a definite hazard. It is safe to say that, during the months of May, June, July, and August, anywhere from one to 20 of these spiders could be found around the garages and outbuildings of almost any dwelling in southern California—while I have captured as many as 25 about numerous houses, my own included. Throughout the entire South and Southwest, *Latrodectus* was found in teeming numbers. The spider breeds more prolifically in warmer climates, but this seems to be no criterion, as general reports indicate that it is more or less abundant in almost every state in the Union.

A BREEDING ground was discovered in San Diego in January, 1935, when workers, preparing a new parade ground with a grading machine, uncovered thousands of baby spiders, which had just been hatched from eggs. Navy recruits were called from the training station to go over the ground with blow torches and burn out every possible hiding place. The county agricultural department reported that the "nest" was the largest ever recorded. No doubt there are others throughout the section that will continue to send forth promising young Widows unless they are unearthed.

Since the female *Latrodectae* often spin their webs close together in some particularly favorable spot during the regular egg-laying seasons of April, May, June, and July, the proximity of the cocoons at the time of hatching probably accounts for these so-called "breeding-nests." When you consider that each female spider spins from one to seven cocoons in a season, and that each cocoon contains between 200 and 300 eggs, you can begin to imagine the incredible numbers of these arachnids hatched into the world in such a breeding section. Not all the little spiders reach the outside world, however, as the weaker are devoured inside the cocoon, and only the strongest remain to bite their way through the egg-sac. Soon after their chitin-covered bodies have become toughened by the outer atmosphere, the baby *Latrodectae* start spinning webbing which, when caught by the breezes, carries them aloft and distributes them over the countryside.

The egg laying process is very interesting, and is a sight seldom witnessed by human eyes. The female, swollen to large proportions by the fertilized and developed eggs, hangs in a perpendicular position, head and fore legs upward, and begins a peculiar, swaying motion by pulling the body forward with the legs. As this continues, the genital flap in the abdomen starts to open and close. When the muscular exertion is at the proper pitch, the tiny, butter-colored eggs are forced out in clusters, the last of which requires such effort that the spider's abdomen is greatly wrinkled and contracted, having shrunk to less than half its former size.

As soon as the mass of eggs is deposited in the web, the spider commences the long task of covering it with

An appropriate place for a Black Widow home. In fatal cases death will occur in from 18 to 36 hours

her viscous webbing. In order to do this, she takes a position before the eggs and carries the strands of wet webbing from her spinnerets under and over the cluster with her long rear legs, working around and around, until the sac is complete. When fresh, the cocoon is pure, silky white, but as it dries, the surface becomes tan or yellowish and is extremely tough. It has been said that the fluid from the crushed eggs is as poisonous as the venom of the adult spider.

The time required for the young spiders to develop and hatch seems to vary, according to my observation, with changes in atmospheric temperatures. If they are kept in a warm place, and a few drops of water are placed in the jar, the time of hatching is hastened. When the baby spiders finally make an appearance they are white, with two or three rows of black dots running down the back. The outline of the "hour-glass" is also visible, but for quite a while after they have started to grow this remains white, and when the body begins to darken, the hour-glass commences to take on its reddish hue.

The male *Lactrodectus* is not often encountered. He is a meager individual, easily recognized by the conspicuous bulbs on the ends of his palpae, as well as by the stripes on his sides and back. The hour-glass is generally present on the underside of the abdomen, but is a dirty white or yellowish color, instead of the bright crimson of the female. Mr. Black Widow gets short shrift from the "Mrs.," who pursues him with grim determination during the mating season, often only to devour the luckless fellow after her eggs are fertilized.

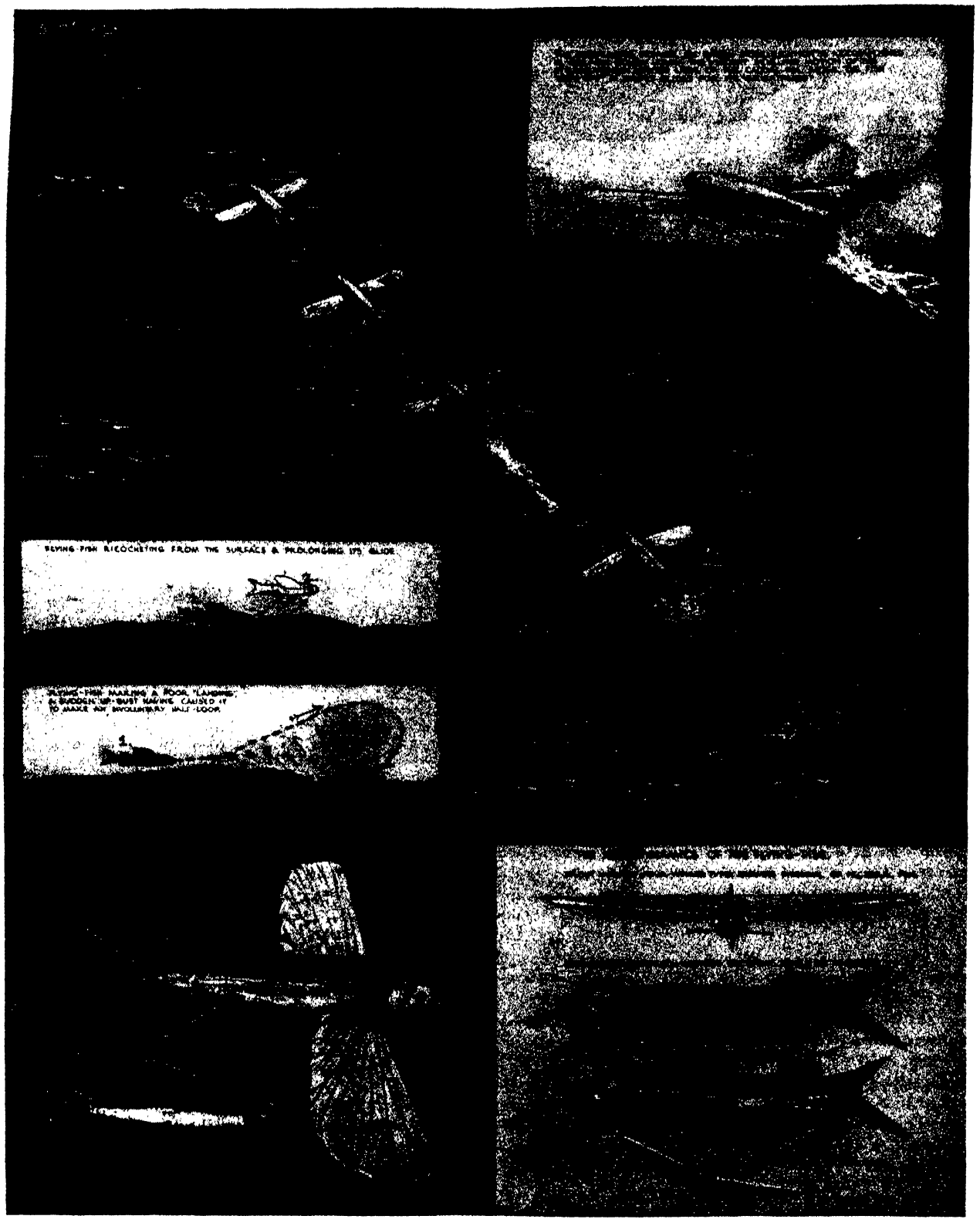
The Black Widow family, as well as other spider families, is often the prey of large hunting wasps and certain parasitic flies. The former enemies paralyze the spiders with the numbing poison from their stings and carry them off to be stored in their nests as food for the wasp larvae. The mud-dauber wasps, whose nests one often washes from the sides of the house or garage with the hose, are said to be particularly Black Widow minded, as far as their diet is concerned, but so far I have failed to find any spiders of this species in a good many mud-dauber nests I have examined.

THE University of California recently announced their discovery of two kinds of wasps that lay their eggs in the cocoons of the Black Widow. The larvae that hatch out are said to devour the baby spiders. If enough of these wasps could be raised and released in spider-infested areas, it would doubtless do much toward keeping the ever-increasing numbers of Black Widows under control.

As I glance up from my writing at the row of jars on my desk before me, I see a formidable array of *Latrodectae*. In one jar on the very end is a forlorn little male—"Mr. Black Widow." What a harem he has! He is minus a front leg—doubtless the result of the violent attentions he has received from a buxom Widow. My latest captive is contentedly dining on a huge, green fly, and perhaps trying to watch me with three or four of her silvery eyes as I write.

●

EDITOR'S NOTE: *As the author has just stated, some wasps, notably the blue mud dauber, attack the Black Widow spider, and it is believed that the field mouse and other small mammals also dispose of many, as do chickens with impunity. However, not too optimistic a dependence is to be placed upon expectations of this kind. Newspaper accounts without end have told us how this or that parasitic insect, bred to attack other insects, was soon to wipe them off the earth; by the time the extermination was supposed to have been accomplished, most of us have forgotten all about the matter. Nature has her own balances that usually prevent such ideal outcomes.*



NATURE'S SEAPLANES—THE FLYING FISH

JUST how flying fish conduct their flight is a matter of some question or at least some argument, many observers having reported slightly different opinions. In the Annual Report of the Smithsonian Institution, Professor Carl L. Hubbs, Curator of Fishes in the Museum of Zoology at the University of Michigan, gives his explanation and from this *The Illustrated London News* commissioned the artist, G. H. Davis, to make the drawings shown above, reproduced by courtesy.

"From very prolonged observation," *The Illustrated London News* notes, "Mr. Carl L. Hubbs states that the fish get up the necessary impetus to fly by a rapid sculling movement of the strengthened lower lobe of the caudal fin or tail. The lobe makes 50 to 70 complete double vibrations per second. When the fish are in the air the pectoral fins are not 'flapped' like the wings of a bird, but are simply used as supporting surfaces, like the planes of an aircraft. The fish, when clear of the water, glides, its flights being of quite short duration." When beneath the surface the wings are folded.

OUR POINT OF VIEW

Little Science

EVER with us are those who criticize science for its hypotheses and theories, for its abstractions and its apparently non-utilitarian findings, who characterize men of science as cloistered and smug. Some there are who say that science is too far ahead of ordinary mortals and so should declare a holiday. The little things in science, the abstractions, the accidents are scoffed at as of no earthly use. Yet an accumulation of those little things often makes one big, important one; indeed, one abstract finding of a dreamy-eyed scientist, or one accident may later be of such enormous value to civilization as to justify, almost alone, the entire scientific scheme.

Forty years ago a Washington biologist made a chance discovery. Dr. Paul Bartsch, now curator of mollusks of the Smithsonian Institution, was then collecting every variety of snails around the District of Columbia. He was puzzled to find that those from the Potomac differed considerably from those in brooks running into the river. There was no physical barrier to keep the species apart, so he looked further for the reason and found it. The Potomac is slightly alkaline; tributary brooks slightly acid. Some kinds of snails live only in an alkaline environment; others only in an acid one. This was an interesting abstract finding but of "no earthly use" so Dr. Bartsch simply recorded it in his notebook.

The scene changes: 200,000,000 people in China, Japan, Formosa, the Philippines suffer from a strange malady, often fatal. Long study showed that this disease, schistosomiasis, was caused by a tiny worm, or blood fluke, which bored into the body and swam in the blood stream. Where it came from no one knew until Japanese investigators turned up another "little thing." They discovered that the larva of this blood fluke invariably lives in a certain kind of snail while undergoing metamorphosis into a form ready to attack people and certain animals. Bare-legged workers in rice paddies could hardly escape; few did. Cures afforded relief only until re-infection.

Now to the accumulation of abstractions was added the fact that the host for this blood fluke larva is an "acid" snail. Dr. Bartsch's "interesting observation" then showed how these snails could all be killed and, with them, the larvae of the scourge of the Orient. Acid waters were made alkaline by dumping quantities of crushed limestone along the water's edge!

Simple? Yes; every "little thing" in this entire chain! Yet if you ask any one of many millions of orientals who have suffered and seen thousands about them suffer—and many die—from this terrible disease, he'd probably do his equivalent of crossing himself and say: "Yes; simple as any miracle."

Sky Sailing

THE feeling, apparently rather widespread in some quarters, that American exponents of the art and science of gliding are amateurs, taking a back seat when foreign pilots perform, received a rather vigorous set-back at the recent glider meet at Elmira, New York. Among other notable flights at that congress was one that terminated at a point 146.6 miles from the start and that consumed five hours and forty minutes in the air. Another motorless ship reached an altitude of 6516 feet.

The study and engineering skill that have gone into the construction of these frail but sturdy ships, the aptitude for this type of navigation shown by the pilots, and the public interest aroused by the meet have culminated in a decision by the Soaring Society of America to make next year's meet international in character. It is reported that at least 10,000 dollars in cash prizes will be available by that time to induce foreign glider pilots to make the trip and compete with the Americans.

Gliding has long been a prominent part of aviation in Europe; many spectacular flights have been made and a large number of trained and experienced pilots are available. If enthusiasm counts for anything, the American pilots will make a creditable showing next year. The outcome of the meet will be watched with interest, from a sporting as well as a scientific point of view.

Patent Centennial

ON July 4, 1836—a fitting day—a "right" was granted by Act of Congress to American citizens. That Act set up a system which has since been enormously influential in the technical and industrial progress of the United States, for it inaugurated our present patent system, under which all rights to an invention are granted to the inventor. Patent No. 1 of the present series was issued July 13, 1836, to John Ruggles of Thomaston, Maine. Since then over 2,045,000 have been granted.

Retrospection, on this hundredth anniversary, must give us pause. Marvels of applied science, of ingenuity, and of accidental discovery have followed patent No. 1 through the Patent Office. When it was granted, electricity still was to be harnessed; the incandescent electric lamp was still far below the horizon; the phonograph, moving pictures, automobiles, radio, airplanes, and numerous other devices and machines on which great industries have been built were still in the offing. Indeed, many important inventions had not even been envisioned.

Patents were granted by the Colonies as early as 1641, while the first patent law of the Federal government was passed in 1790. At the time each patent was signed by the president, the secretary of state, and the attorney general, but the secretary of war also sat on the patent-granting committee. Control was so rigid in those days that in the first year only three patents were granted, and in three years only 57. Popular demand caused a revision to the other extreme. People then patented almost anything and everything new or old. Since this was so loose a system and afforded no real protection, the same John Ruggles mentioned above worked for and succeeded in having the present system established by law. Without precedent in history, the new law made a patent grant a prima facie standard of validity.

While American patent practice has been revised under the impulse of changing conditions, it is, basically, the same as our forefathers planned it 100 years ago. Under it the government secures the right of the inventor. In our system, he has an inherent *right* whereas in England, for example, the Crown grants a *privilege* for a sort of monopolistic concession.

In 100 years under our patent system, we have traveled far. Most people give it credit for our world leadership in industry for, despite its admitted defects, it has proved to be eminently practical. Revisions may be necessary—indeed, have recently been suggested by a Science Advisory Board committee—but when they come they must be based upon common sense and understanding. They will be predicated upon the need for adjustments to evolutionary changes; the country will countenance interference for no other reason.

ARCHEOLOGY FROM THE AIR

The Archeologist Standing on the Earth's Surface is "Too Close to the Trees to See the Woods" but Air Photography Reveals a New Crop of Discoveries

By STANLEY CASSON, M.A., F.S.A.
Author of "The Progress of Archeology"

AS modern methods of excavation develop, much more about archeology is found out. Many sites such as Troy and Mycenæ, originally dug by the more rapid and less scrutinising methods of two generations ago, have had to be re-excavated in order to find facts which had either passed unnoticed or which can only be detected as a result of the increased knowledge of today. British excavations at Mycenæ shortly after the war, and the present extensive American campaign at Troy, are some contribution towards the correction of the errors of the earlier excavations and the discovery of evidence obviously missed or ignored by the first excavators.

Chief among the external aids which the modern archeologist has called to his assistance is air photography. At present its use is confined mainly to those countries where aviation is popular and where sufficient funds are forthcoming to subsidize its use in archeology.

The application of air observation to excavation was a product of the World War. Pioneer work was carried out by the Germans in the Sinai peninsula, and an archeological commission working with the German army in Palestine was under the command of an archeological professor, Dr. Wiegand. Here, for the first time, in a volume published after the War, it was possible to see direct photographs of almost unknown cities, ruined and forgotten, in the wilderness of Sinai. The same region was mapped and examined from the ground by Colonel Lawrence just before the outbreak of hostilities. It is interesting to compare Lawrence's ground researches with those carried out by air.

About the same time that these researches were being conducted, British aviators were able to record unknown sites in Mesopotamia. It is thus uncertain to which nation must be given the credit of instituting archeological research on these lines. The German undertaking seems to have been greater and more detailed, the British a study of a more important region.

The archeologist on the ground is to a large extent heavily handicapped when it comes to an exploration of a wide area in the search for sites to dig. He is in the position of a man who sees a half-tone illustration only through a strong magnifying glass. The illustration is largely an unmeaning mass of dots which only extreme ingenuity can piece into the proper pattern. But a long-distance view at once makes the pattern clear. The aviator can take precisely this long-distance view over large areas of land.

The identification of ancient city sites in deserted regions that are difficult to explore on foot is a simple enough task for the aerial observer at a great height. It is when he comes lower that he can help even more. What he detects is not so much the unevennesses of the soil as the changes in color of the soil itself and of the vegetation on it. Soil once turned is never the same again and the vegetation that grows on it indicates the parts of the soil that have undergone artificial handling. One of the most convincing of recent aerial photographs shows how even the tallest trees reflect in their topmost foliage what has gone on about their roots. A view taken of the forest surface in the wild jungle lands of Yucatan shows how the absolutely straight roads cut through the forest by the Maya of a millenium and a half ago, now survive as long straight channels in the level surface of the forest. This can be detected only in an oblique and very high altitude view. It is almost certain that this system of roads would never have been discovered by ground observation alone.

Figure 1: An air photograph of the site of a prehistoric wooden circle near Norwich, Norfolk, England. For centuries people have tramped over these evidences but the ability to see them from above, as a whole, came only with the airplane

IN mud desert lands like Mesopotamia the air view is of superlative value, for the slightest changes in color of crops and herbage are at once seen from the air. In rocky lands like Greece land surveys by air will reveal very little. In western Europe, on the other hand, the grassy soil and frequent occurrence of chalk downs is peculiarly susceptible to aerial survey. Chalk areas in particular reveal from a height the outlines of every furrow and every ditch or encampment ever made, even if they have been plowed level with the surface long ago.

The full use of air photography in excavation is now in operation in England, where it took root first in 1922. It is

not merely a question of taking a photograph of a site not otherwise known, and then having that site excavated. The aviator now co-operates with the excavators, taking photographs before, during, and after the excavations, so that the excavators shall make no mistake and miss nothing.

The air photograph often reveals, not what is otherwise invisible to the ordinary eye, but rather what would normally pass unnoticed. Just as the skeleton never vanishes, so the changes wrought by human agency on the surface of the earth can never be removed and obliterated. It has been rightly said that the one thing which you can never destroy or obliterate is a hole in the ground. Fill it up, stamp on it, cover it up as you will, always it will emerge like Eugene Aram's victim. And there lies the clue to the value of air photography. Photographs taken from a vertical point of view will reveal all the markings left on the soil by man's agency. Photographs taken obliquely in a slanting sun will show, even in the growing crops, the outlines of long-vanished foundations and the darker patches left by disturbances of the soil. For, once you alter the settled stratifications of the natural soil that Nature has laid down, you can never put them back again in the way in which Nature did it herself.

FOR nearly a generation now, archeologists have been in the habit of plotting out the plans of long-vanished wooden buildings solely by the aid of the holes left in the soil by the posts and beams of the building. These holes, under excavation, appear as deposits of darker earth, unstratified and loose in the solid matrix of the natural soil. Recently air photographs taken in England have revealed whole structures of this kind. The post-holes show up as dark points on the surface, whether it be turf or grain.

A notable discovery of the first order was made, in this way, of a prehistoric circle similar to Stonehenge and only two miles distant from it. But this other circle was originally composed of wooden uprights of massive oak instead of stone pillars as at Stonehenge. Perhaps it was the predecessor in type of Stonehenge. The airplane photograph enabled the excavators to draw the plan of the circle; subsequent excavation showed the plan to be correct, and every detail of the photograph could then be examined on the earth. So emerged one of the most important monuments of British prehistory. The discovery led to further search and other circles were found, thus adding a whole new chapter to British archeology. Figure 1 shows one of the latest to be discovered. To the right of the center of the picture is seen a double circle. The inner circle is actually more like a horseshoe, and in type follows closely on the lines of the inner circle of Stonehenge. The actual circle is near the city of Norwich in Norfolk. Within the horseshoe circle is faintly seen a smaller circle of small dots. These are the marks left by the holes in which immense wooden posts were set up when the shrine was first made, some 4000 years ago.

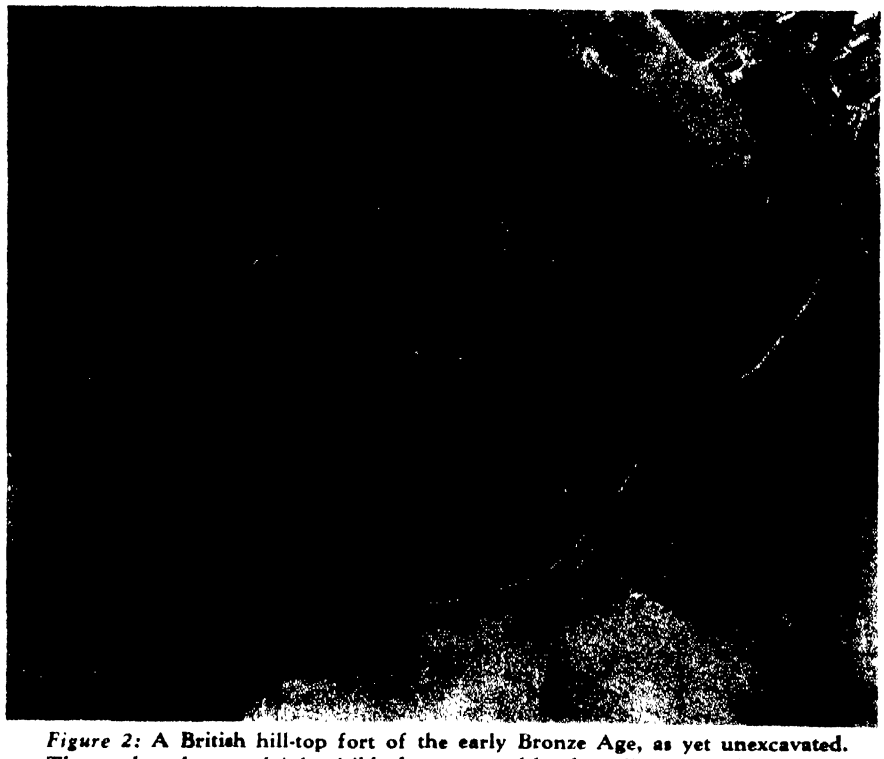


Figure 2: **A British hill-top fort of the early Bronze Age, as yet unexcavated. The earthworks are plainly visible from ground level—still more so from above**

All these circular markings are seen on a turf surface and are almost invisible from the ground level. The darkness of the circles is due solely to the more luxuriant growth of grass on a basis of disturbed soil, and the circles represent ditches that surrounded the central wooden shrine. To the left of the twin circle is a small circle in the middle of a field. This is the site of a burial mound, long since plowed level with the soil but surviving in the color of the grass.

Since this photograph was taken excavations have been carried out and everything indicated on the photographs was found. The ditches were found cut into the natural soil and filled with disturbed earth; the deep holes for the posts of wood were found exactly as shown and it was even possible to discover, from traces on the soil, that all the tree-trunks employed were dragged down the slopes of a neighboring hill to be put into this position.

Photographs taken vertically of prehistoric camps reveal admirably the full details of these astonishing fortresses that top almost every large hill in the south of England. Figure 2 is almost oval and, unlike most camps, has no proper gateway. Figure 3 shows the largest earthwork in England, Maiden Castle near Dorchester in Dorset, which, since the photograph was taken, has also been excavated. The white arrow points to a spot in the mighty ramparts where there is a curious kink. Across the flat turf surface of the interior is seen an irregular line. The photographs suggested that this was the outline of a first fort, smaller and more compact than the fort in its final state. This was verified later by excavation, and the remains of an old rampart were found running across from the arrow point to the opposite ditch.

FIGURE 4 shows an excavation in progress in Ireland, where an expedition from Harvard University is excavating an early Irish settlement of the Christian era. Here the wooden piles of a building, once on a lake edge, are seen, with a dugout boat intact, found where it had finally sunk in its quay when the settlement was abandoned. Only careful and meticulous excavation has made it possible to preserve the outlines of this settlement and its contents.

One aspect of air photography remains to be developed. Hitherto it has not been employed, partly because the regions where it would be most useful are not well endowed with money or with aircraft, partly because the use of aircraft in archeology is by no means universal even in regions where archeological research is intensive. This new venture for air photography I will term "air-marine research". It concerns the Mediterranean more than any other region—perhaps exclusively. By its means air observation can be applied to the

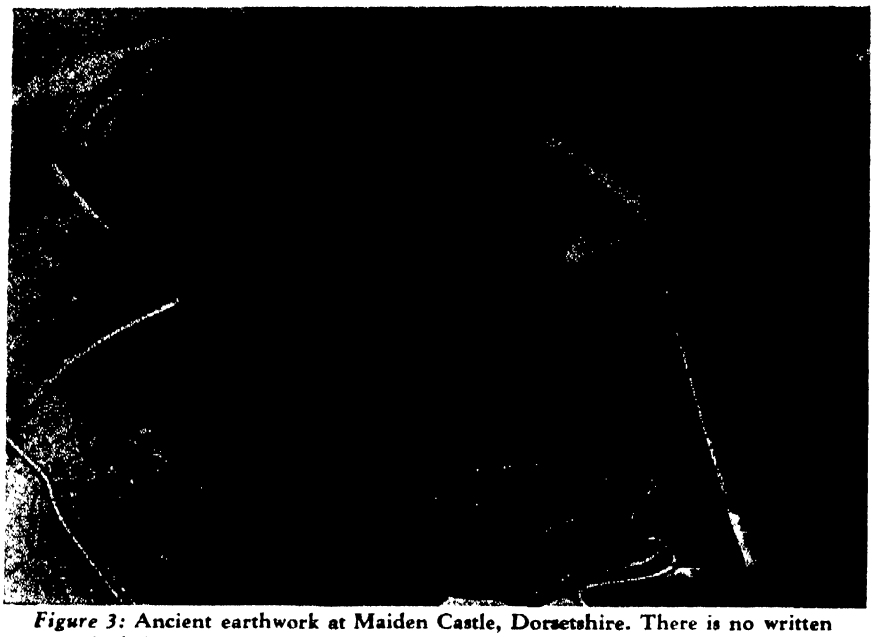


Figure 3: **Ancient earthwork at Maiden Castle, Dorsetshire. There is no written record of the people who built these great forts of earth on hill-tops in Britain**

examination and discovery of objects of antiquity now under water on the sea-bed. These fall into two classes: (1) towns or buildings which have been submerged under the sea by land-subsidence and (2) remains of ships wrecked in antiquity. Archeologists are now seeking both the means and the opportunity for such research. The results are certain to be of the highest importance. Let me give examples of cases in each class.

In class (1) can be placed a complete Greek city of later Hellenistic date in South Russia on the Crimean coast. Russian archeologists have recently identified it by means of marine telescope observation and divers. But their knowledge of it is only approximate. The city is recorded by a Greek historian as having been finally abandoned when the area became uninhabitable. Apparently in the course of 200 years or so, geologic disturbances forced the level of the city below or just into the sea. Subsequent centuries have completed its submergence.

ANOTHER case is found in the buildings of Roman date in the Bay of Baiæ, near Naples, which are now under the sea. Photographs from the air at a low level would enable accurate plans to be made and divers could then locate details of the site and explore its remains. There could, of course, be no question of scientific excavation, except at prohibitive cost.

In case (2) wrecks of ancient ships which bore as cargoes works of art have been recorded from the coast of Africa, off the island of Cerigo in the Ægean and, in 1930, off Cape Artemisium near Eubœa in central Greece. In each case the wreck was found by chance by sponge fishers and the works of art fished up were recovered more by accident than by design. But the wealth of works of art so found has been enormous. In one African wreck a large number of marble statues were recovered. In the Cerigo wreck one complete bronze statue and about ten marble statues were found, together with a unique example of a Roman astrolabe, which had been one of the ship's instruments of navigation. In the Artemisium wreck what is perhaps the finest of all known Greek works of art was found, the now famous Zeus in bronze at Athens, dating to about 460 B.C., a masterpiece of the first order, in perfect preservation.[1] Sea water tends to ruin stone and to preserve marble, the converse of what happens in the earth.

A systematic examination of all these promontories and straits where wrecks are frequent at all times, carried out as a survey by airplanes, would certainly reveal on clear days traces of wrecks which might then be profitably examined by divers. The addition to our knowledge of Greek and Roman art might well be great. Roman art dealers from 100 B.C. to 400 A.D. looted Greece of its works of art in order to adorn the cities of Rome and Constantinople. By fixing the ancient routes from Greece to Rome and from Greece to Constantinople, and by carrying out such a systematic inquiry, other wrecks beyond those found by mere chance would be discovered. The African coast, even better for aerial observation, would be also worth investigation, for to the new African cities the Romans seem to have brought the works of art of Sicily, which were in the main also Greek. Scholars are now at last beginning to consider this particular and as yet untried form of air research. It should prove fruitful.

[1] Two other works of art in bronze were also found in this wreck, the forepart of a galloping horse, and the quite perfect figure of its rider, a work of the 3rd Century B C. A few weeks ago the bulk of the body of the horse and its hind legs were found by sponge fishers. No exhaustive examination of the site of this wreck has yet been carried out by divers and it is uncertain at present whether other works of art remain to be discovered there. In any case this wreck has proved the most productive of any so far found. The site of the wreck is a well-known danger spot and there may be other similar wrecks in the sea sand.

●

Interested readers may find in the British journal, Antiquity, *a number of accounts of air-photography investigations of sites. For example: "Air Photography in Northern Ireland," Dec. 1930; "Hill Forts," March 1931; "Cerdic and the Cloven Way," Dec. 1931; "Balloon Photography and Archeological Excavation," June 1932; "Some Recent Air Discoveries," Sept. 1933; "The Celtic Field System in South Britain," Dec. 1935. Available in large libraries.*

Figure 4: **An expedition from Harvard University excavating an early Irish settlement of the Christian era. The site was formerly at the edge of a lake, now dry**

WHO'S A GOOD DRIVER?

Opinions Differ . . . Tests Tell . . . The Human Equation Must Be Solved . . . Egotism Solved by Training . . . Privileges for Superior Drivers?

By PHILIP H. SMITH

THE deep-seated conviction of almost every red-blooded American motorist that other drivers are less competent can now be exploded. Scientific study of driving skill has reached the point where facts rather than fancy will decide who is competent and who not.

This is a great step forward in the concerted movement to make the highways safe. Efforts to better road construction and to make automobiles themselves safer is all to the good, but in the last analysis the human equation has to be solved. Roads and vehicles are important factors, but they are used by human beings—mis-used or properly used.

Recent studies, and many have been made in various parts of the country, have brought to light several unexpected facts about the man at the wheel, and perhaps the most important of these is that the majority of drivers are unaware of their own limitations. Confidence in your own ability may mean only that you are ignorant of your defects. You may cite with pride the fact that you have had no accidents; it may mean merely that you have been lucky thus far in your motor-car career.

Conviction of personal excellence in driving is hard to deflate, but if excellence does not exist, the highway has a potential hazard until the deflationary job is done and done well. When a driver learns of his limitations, he is the better for it and can be trained to overcome them. The instruments which have been developed to do the revealing are convincing—and strikingly ingenious.

THE Bureau of Street Traffic Research at Harvard University, under the direction of Dr. Miller McClintock, has a most comprehensive group of instruments and tests. Critical examination of these will give the best possible idea of the progress made in measuring driving ability, because the objectives sought are representative of present day scientific effort. So far, seven tests have been developed and these are generally credited with making possible the grading of drivers in a practical way.

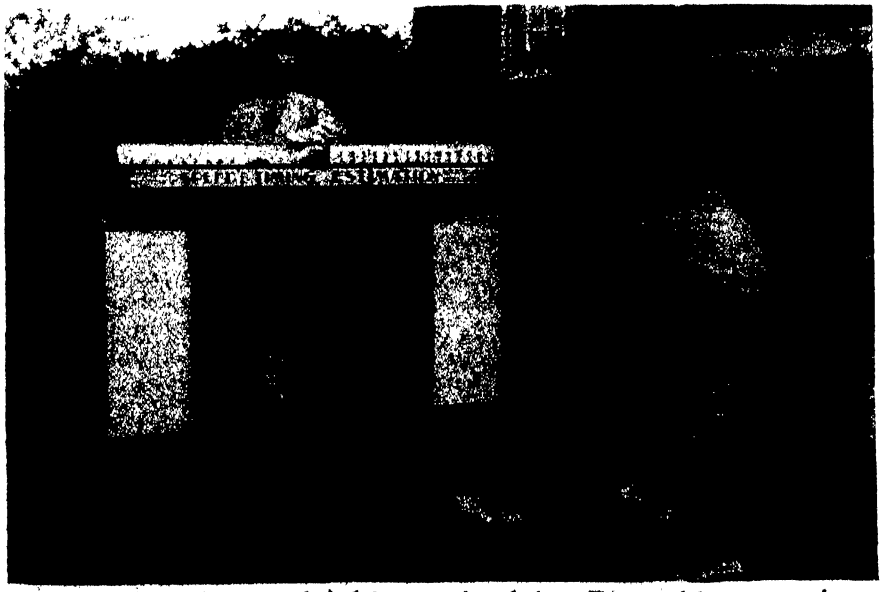
The first and simplest test is for braking reaction. If your reaction time is better than 0.44 second, you are above average. This timing means the interval between taking your foot off the accelerator and applying the brakes when a light in front of you changes from green to red, or when you face an emergency.

Steering skill test. Subject must manipulate the steering wheel to hold the miniature "road"

Steering skill is measured by seating the subject in a chair, facing a road scene which unrolls before him and is so arranged that steering is required to "hold the road." There has been found to be a close correlation between steering skill and driving experience. Other discoveries have been that women learn to steer more slowly than men but improve over a longer period; that the highest scores are made between the ages of 17 and 21, and that driving coordination wanes after 55.

The driver who would overtake and pass a car while another car approaches him must have ability to judge both speed and time, and this constitutes the third test. Two model cars are used and caused to move at right angles to the subject. The instrument itself resembles an elongated box, with the center cut away and the remaining surfaces clearly scaled. In operation, the first model emerges from the enclosure and travels across the cut-away area, promptly pursued by the second model traveling at a higher speed. When both models have disappeared, the subject is asked to estimate where, on the scaled surface, the pursuing car will catch up with the other.

Visual tests, of which several types have been developed, are of prime im-



A test subject, foreground, judging speed and time. Two model cars pass the opening in the box; subject must judge where they will meet, under cover

portance. They endeavor to measure glare-blindness, depth perception, "tunnel" vision, visual acuity, and color-blindness. Apparatus to test for the first simulates road conditions in miniature. The subject looks into a closed box where he perceives the oncoming headlights of an automobile. At the right of this road is a cardboard "pedestrian." The subject has his own set of headlights, the intensity of which he must increase until he can see the pedestrian. Scoring, or the measure of blindness, is based on the increased brightness needed to do this.

DEPTH perception and "tunnel" vision are both of great significance on the highway. If a driver lacks the first he is handicapped in passing; if possessed of tunnel vision he sees straight ahead and misses entirely a quick perception of cars coming from the side. Depth perception can be measured with an apparatus comprising two vertical rods, one fixed, the other movable forward and backward at the will of the subject. The test involves lining up the rods side by side from a distance of 20 feet.

Tunnel vision is being tested by means of a perimeter. The subject looks straight ahead at his own image in a mirror while the operator moves a light box to right or left of the center until it passes from vision. If the subject's vision is restricted to less than 60 degrees on either side his visual condition is declared hazardous.

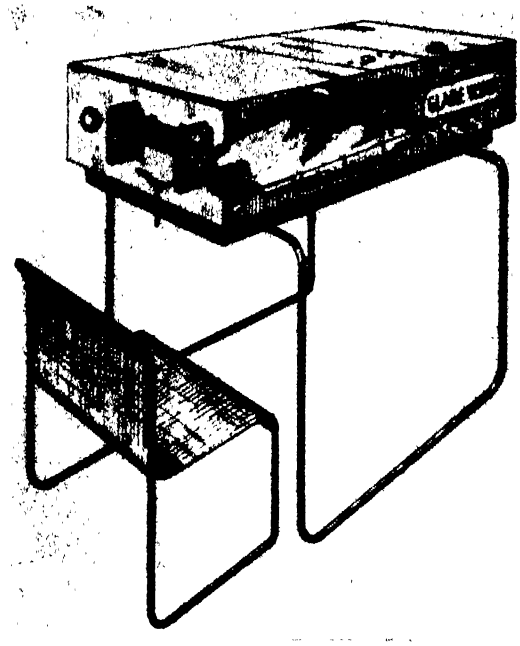
A ring test serves to measure visual acuity. The subject views a series of increasingly smaller rings, each having a gap, until the gap is no longer visible. Color-blindness is measured by an equally simple device. Here the subject simply states the color seen through a hole in a box and guessing is precluded by presentation of colors without regular sequence. A test for hearing completes the tests of individual abilities and there is no special apparatus required for this because auditory testing devices have been available for many years.

If the tests as outlined constituted all there is to the measuring of driving skill, we would have to admit that few advances of a practical nature had been made. The tests would leave still undetermined a driver's capacity to perform a number of operations simultaneously or in rapid sequence as required in actual highway driving. They would leave untested a driver's judgment when faced with a complex situation. What they do achieve is the uncovering of weaknesses of which the driver may be wholly unaware and which would make him prone to accidents.

Workers in the accident-prevention field have seen the need for devising tests which simulate more accurately actual driving conditions, if a real determination of skill is to be obtained. At Harvard the need is met with a miniature highway apparatus; at Iowa State College an outdoor driving field has been developed. Both serve to put the driver under observation while reacting to a series of highway situations.

The miniature highway apparatus comprises the control compartment of a standard automobile and an endless belt highway upon which car models are mounted. The road is seen through a small window to give the illusion of looking through a windshield and the vision is a normal one of oncoming cars and cars traveling ahead. The belt is so arranged that it begins to move when the subject goes through the operation of getting a car under way; the models move faster as the gears are shifted, and further acceleration is given by the throttle. Steering is also linked to the belt. Thus a turn of the wheel moves the belt to one side or the other to create the illusion that the subject's car has moved to the right or left of the highway.

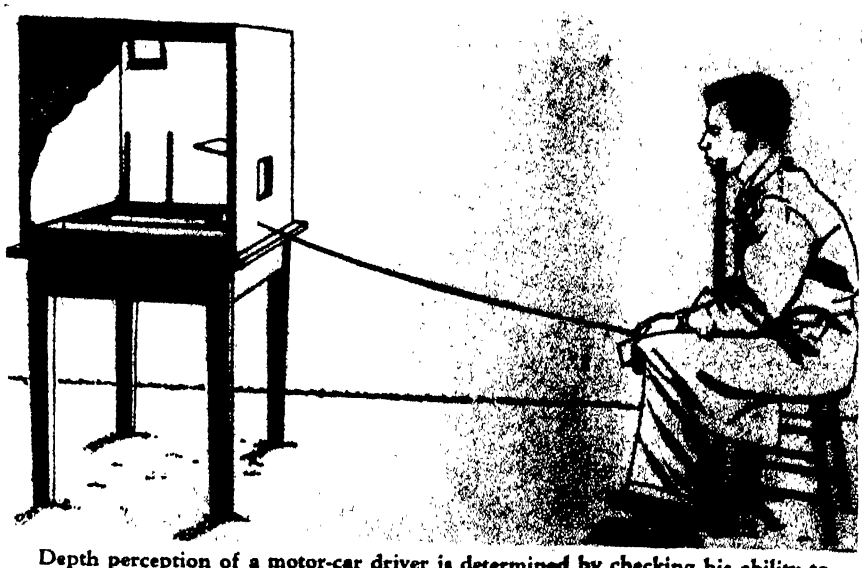
Manipulation of the car controls enables the subject to speed up, pass cars, slow down, stop, and so forth. He must judge distances, speeds, timing, and in short, behave as he would behind the wheel of his own car. In the course of about three minutes he encounters as many hazards as he would normally meet in about one year on the road and his performance can be observed and recorded.



The subject adjusts his "headlights" until he can just discern the cardboard "pedestrian"

The Iowa State driving field likewise simulates actual road conditions. The subject taking his car through the field must obey all signs and rules of the road and react promptly to all instructions. It tests his ability to steer, brake, park, obey signs, not to mention noticing and reading them. In addition to testing, this field can be used for training.

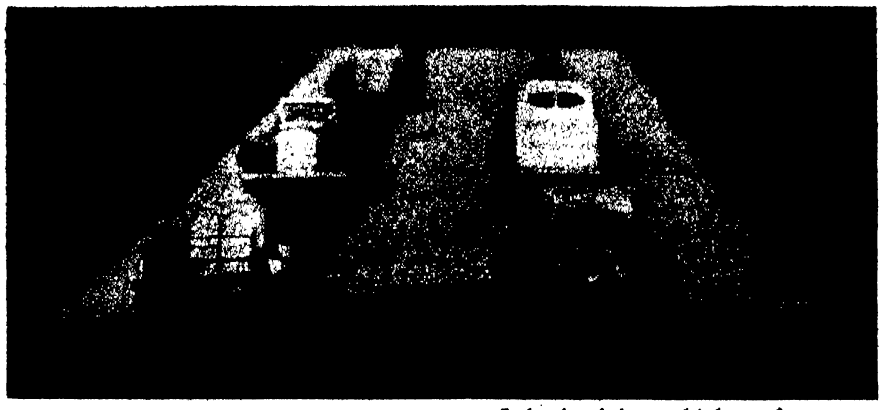
While experimenters agree that driving tests now used by state motor vehicle officials are entirely inadequate to meet the needs of present day driving, they make no pretense that their own tests are infallible. They hold their methods to be more exploratory than conclusive, yet to make a definite contribution to the work of accident prevention. The revelation of driver limitations still leaves the elimination of accidents up to the driver. The best that tests can do is to find the unfit so that they can be

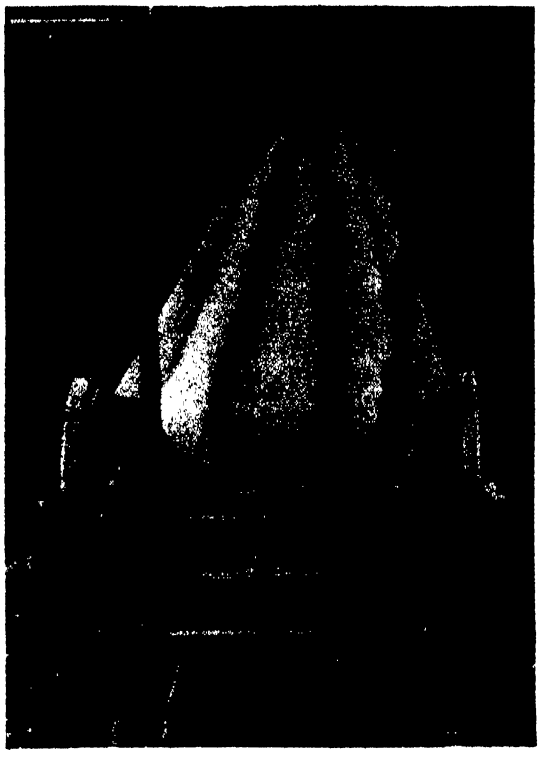


Depth perception of a motor-car driver is determined by checking his ability to align the two vertical rods in the cabinet. One of them is controlled by two strings

eliminated from the highways and show the way to train the rest to become more capable. Certainly the first step in accident avoidance is to know one's limitations.

The purpose of current experimentation is primarily to make better drivers rather than to restrict driving. Tests show that drivers who cannot avoid accidents comprise a group of not more than 5 percent of motorists, while those who have some weakness to make them accident-liable number about 20 percent. This leaves 75 percent of drivers who can benefit from the knowledge that follows from research.





Left: **A miniature highway for testing driving skill under highway driving conditions.** *Above:* **What the subject sees through the windshield of the new testing equipment**

THE weakness of present testing methods are those inherent in most tests of human material. A test is something exceptional and not psychologically identical with the everyday counterpart. The poor driver tries his best, while all persons concentrate on what they are doing to a degree not likely to be exercised on the road. Experimenters realize the need for eliminating this element from tests to get worthwhile results. At Harvard they will make the miniature highway more complex to simulate road conditions more closely, and so operative that results will be recorded mechanically, thus eliminating at least the psychological factor of the observer from all calculations.

If driving tests are ever to be put into operation on a nationwide scale as a means for determining fitness for the granting of a license, the recording of factual data must be standardized and mechanized so that results depend in no way upon the ability of the tester. This will be done because the value of an established scientific base would be dissipated quickly if so vital a link were left uncontrolled.

While researchers claim that tests will now reveal faults in driving so that the driver can be advised and learn what to do about it, they are not in unanimous agreement that testing principles have been so well established that inferior and superior drivers can be separated, nor are they in complete accord in the opinion that inferior performance *per se* indicates proneness to accidents. With true scientific detachment they view their work as merely a beginning and are working to make their studies more conclusive. They see many physiological reactions yet to be studied and suspect that there may be more factors which go to make up driving skill that have not been discovered and that may be determined only by careful research, assiduously followed.

Driving tests must be checked from all angles to be really scientific and this check is made by correlating with actual highway performance. Two ways are followed—watching the performance of drivers who have been tested, and testing persons who have accident records. The Harvard system of tests is now being applied to Cambridge drivers who have been involved in accidents to see what the correlation may be. Ultimately, for it takes time to build up adequate records, we may know much more about the cause of accidents, for accidents don't just happen; they are usually caused by unthinking or careless drivers.

The immediate value of these tests was made quite apparent recently. Within a few blocks of the examining station a driver passed a red light and ignored a fire engine siren with very sad results. Under normal circumstances the driver might be labeled careless and fined accordingly, but in this case he was tested for driving skill and discovered to be both color-blind and deaf.

It is, of course, possible for a driver to pass strenuous tests and still be a nuisance on the highways; he may still drive as if bent upon turning his car in or turning it over within the year. How then can driving examinations increase safety on the highway? Dr. Alvhh R. Lauer, of Iowa State College, answers this question on six counts. He claims:

First; the type of vehicle best suited to the driver may be adjusted or arranged accordingly.

Second; if drivers know their limitations, they will tend to avoid trouble.

Third; knowledge of the other fellow's weaknesses keeps a driver out of trouble. He makes more allowances.

Fourth; faced with searching examinations, the driver will make more effort to learn the principles of safe driving.

Fifth; a driver will exert more care when made responsible for his weaknesses.

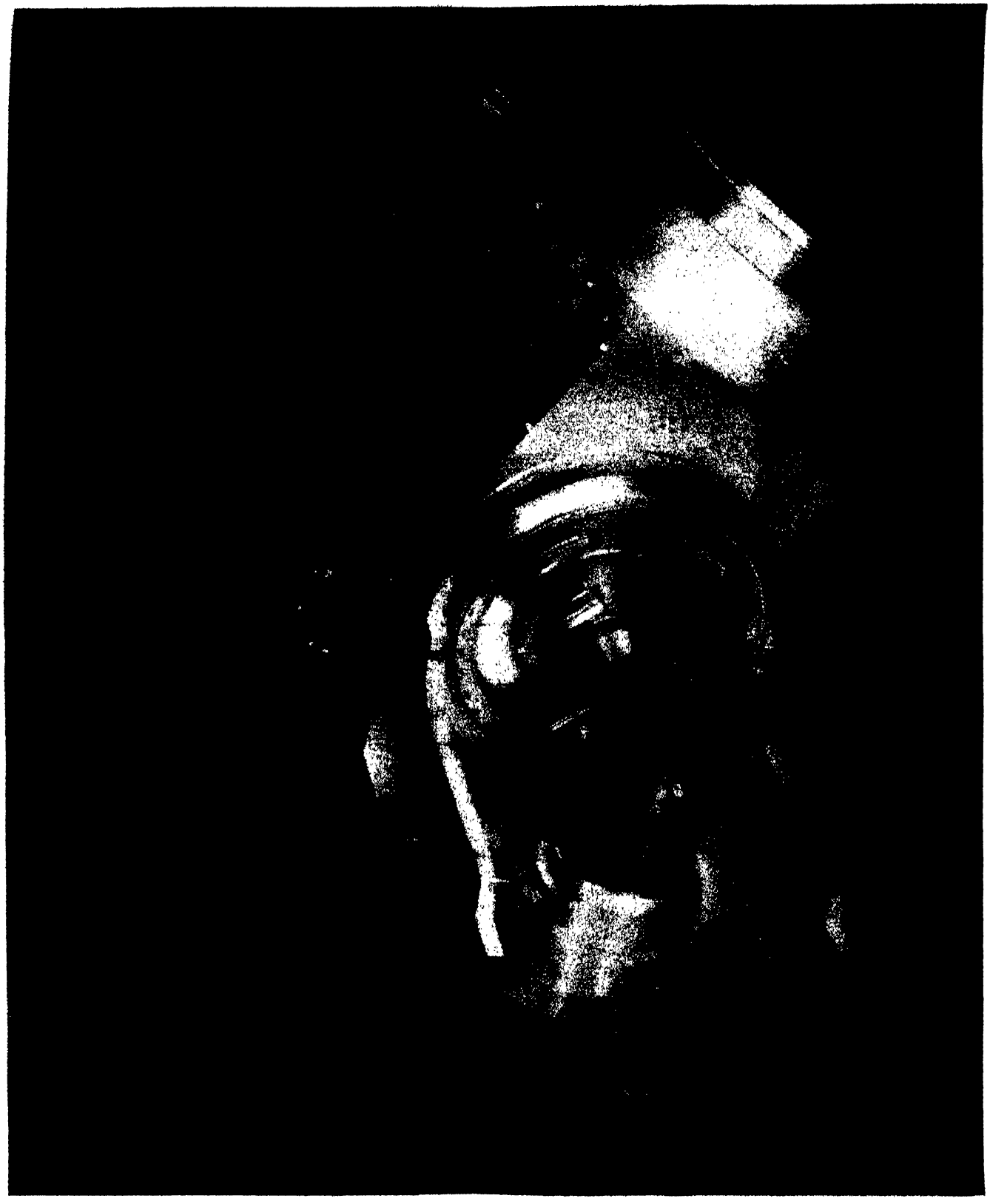
Sixth; proper training can be given because of basing on skill measurements, scientifically obtained.

Dr. H. R. DeSilva of Harvard holds that examining drivers and pointing out their faults to them will go much further toward making the highways safe than repeated admonitions and threats of disbarment from the highway.

CERTAINLY we now have tests that count for something; with the means for grading drivers, the day is not far away when the hopelessly unfit will be taken from behind the wheel, the average driver provided with aids toward increasing his skill, and the superior one perhaps given certain privileges as long as they are respected.

Out of the knowledge that, to avoid accidents, a driver should know his limitations, there can develop the elite of motoring—a group to whose membership all may aspire, for their competence will be factual. Scientific tests point the way to "Know thyself." This is the beginning of driving wisdom.

Photographs courtesy Bureau of Street Traffic Research, Harvard University.



FIRST PRIZE

"Springfield Mounting"

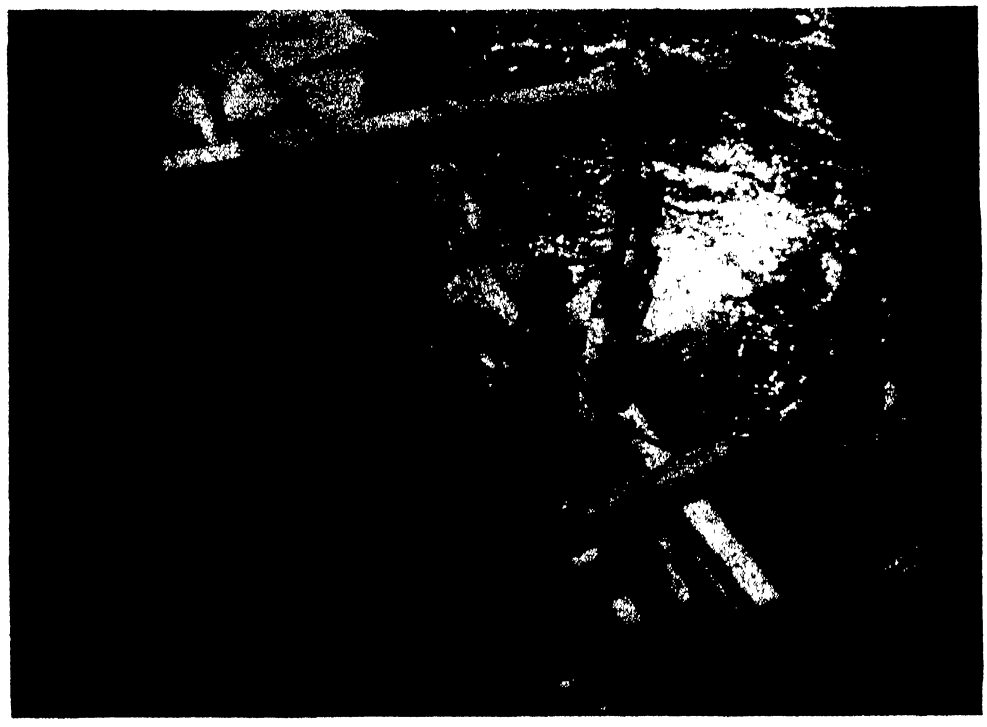
By Robert Bushman, 13 State Street, Schenectady, New York. Subject: Springfield mounting for a 4¼ inch amateur reflecting telescope. Taken with a Graflex Series B, Kodak anastigmat lens, 5½ inch, F/4.5. Negative 3¼ by 4¼ Panatomic developed in D-76. Filter, K2. Exposure, 45 seconds at F/22. Printed on Defender Velour Black Glossy. Light, one Photoflood in a reflector. The light source was kept in motion during the entire exposure to prevent heavy shadows and too bright highlights.

PHOTOGRAPH CONTEST AWARDS

FROM the large number of photographs submitted in the Scientific American Photograph Contest, announced last April, the board of judges has selected the three prize winning pictures reproduced on these two pages. The board consisted of Ivan Dmitri, well-known artist and photographer, Jacob Deschin, conductor of our "Camera Angles" department, and the editorial staff. Announcement of the Honorable Mention awards appears in the "Camera Angles" columns of this issue.

SECOND PRIZE

"Bridge Repair"



By Alex Lighter, Glace Bay, N.S., Canada. Korelle K. camera, F/2.8 Trioplan lens. S.S. Pan film, 35 mm. Exposure 1/100 second at F/4.5. Normal contrast P.M.C. No. 1 paper developed in M.Q. tube developer. Negative developed in buffered borax D-76, for ½ hour.

THIRD PRIZE

"Silvering Telescope Mirror"

By J. M. Stofan, 95 Grand Street, Garfield, New Jersey. Leica camera, Elmar lens used at aperture of F/9. No filter. Light source, two Photoflood lamps. Printed on #3 paper, developed in D-72. The 35-mm film was developed in D-76.

A bridge that *looked* strong enough, but a light sedan went through it

Horse and Buggy Bridges

Forgotten Bridges . . . Old . . . Weak . . . Not Built For Modern Vehicles . . . Narrow . . . Bottlenecks . . . Hamper Traffic . . . Unsafe . . . Endanger Life

By F. D. McHUGH

A LARGE bus, carrying as passengers a score of carefree, chattering youngsters on their way to school, glides smoothly down a modern concrete road. The driver watches a huge truck preceding them and, guessing its loaded weight at 20 tons, wonders absent-mindedly whether that truck can safely cross the old wooden bridge ahead, over a railroad cut, which is posted: "Load limit, 6 tons."

Keeping a safe distance behind, the bus-driver passes a familiar sign: "Warning, Narrow Bridge." He sees the truck ahead rumble off the bridge floor to the concrete beyond, and involuntarily sighs with relief. His bus rides easily on the bridge. He is watching the road ahead and an approaching car for which he must make room. He nears the center when he hears an ominous creaking of old timbers and then—Crash! Floor boards splinter, wooden trusses and stringers buckle, and the bus with its load of happy children dives to the tracks below. A cloud of cindery dust rises for a moment of awful heart-breaking silence. Then, as if by rehearsal, small throats in maimed bodies rend the air with screams that rise to an appalling crescendo. Some voices, chattering but a moment before, will never again be heard.

It is not a pretty sight. Violent death never is; and such slaughter of the innocents is a thing horrendous. Perhaps it has never happened just this way. It could—and may at any time. For someone forgot a bridge!

Bridges, vital highway links, have been forgotten by the thousands. These weak, narrow, and obsolete structures threaten every man, woman, and child in the country. They snatch their toll of lives daily and with every day's depreciation they multiply the death hazard. They void the vaunted safety of the high-speed roads they connect and stand as monuments to the negligence of officials. Authorities who have forgotten these bridges are guilty of flagrant disregard for human life and property. But we, the public, are also culpable.

IT is roads, not bridges, that have been improved. As the use of motor cars has increased at such phenomenal pace during the past two decades, highway departments of town, county, state, and federal government have worked feverishly to provide roads for them. The roads themselves have grown from two lane to three and then four. "Modern roads for modern motor travel" has been the order of the day. As roads were built a new unbalance was created. That Goliath, the transport truck, and creature of a new major industry, highway transportation, demanded highways not only wide and straight, but surfaced to withstand impact.

In rebuilding highways to keep pace with modern transportation needs, engineers often left old bridges in place, allowed the "horse and buggy" bridge to remain, or at best they built for the cars and lighter trucks of other days. Many responsible officials, in common with many laymen, look upon a bridge as a permanent fixture, something to serve until it falls down. As a consequence, one engineer recently told us, "Numerous old bridges in various stages of obsolescence remain to make our highways unsafe despite all sincere attempts to provide new grades, better alignment, and more permanent surfacing." They are, indeed, the weak links in the chain.

Such "weak links"—thousands of them—are everywhere throughout the country. No one has bothered to keep statistics as to the approximate total, but every one who has driven a few miles in the country, particularly on two-lane or secondary roads, can vouch for their existence in numbers. Some will be posted, as is an old masonry bridge near Yonkers, New York: "Steep Hill—Narrow Bridge"; some, as is one we know in West Virginia: "Bad Curve—Narrow Bridge"; while many will frankly confess negligence of responsible persons by some such warning as: "Danger—Load Limit 6 tons."

Some will be of masonry construction, some of old concrete, some of rusted steel, and many of wood. In 1930 there were in use between 450 and 500 old covered bridges (wooden) in 24 states ("A History of the Development of Wooden Bridges," by Robert Fletcher and J. P. Snow, *Proceedings A.S.C.E.*, November, 1932), and many of these—rattly, narrow, and with sharp curve approaches—are doubtless still serving. We know one such on a splendid, new, two-lane, concrete highway in South Carolina.

Accidents, which will be discussed later, have occurred at numbers of these obsolete bridges; they have exacted their toll of lives. All are dangerous despite their warning signs which are continually ignored, and all, even on the secondary roads, are crossed many times by heavily loaded, law-breaking trucks.

"I have a neighbor who makes a living by trucking," says H. E. Colburn, Bridge Engineer of the Allegany County (New York) Department of Highways. "His truck, empty, weighs six tons and he ordinarily hauls a load of eight or ten tons, making a total load of about 15 tons. He cannot get three miles away from his home, with his empty truck, on any road in any direction, except one, without exceeding the posted limits of some bridge, thereby making himself liable to arrest besides taking his life in his hands. On the road which he has the most occasion to travel—a State road—he has to cross one bridge posted for six tons and another posted for four tons in traveling four miles to a gravel plant. Yet he pays the state over 100 dollars license fee every year for the privilege of operating his truck, as well as a substantial additional sum in gasoline taxes.

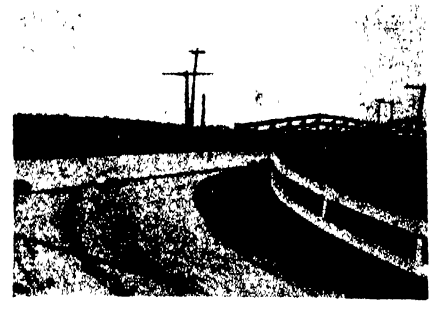
"A few days ago, near here, a gasoline truck weighing 20 tons went through an old bridge posted for four tons. The owner or driver will undoubtedly be prosecuted, fined a nominal sum, and then will proceed to haul heavy loads as usual over weak bridges. Some time ago a chain store truck broke through a bridge on the main route near the village of Belmont. The load greatly exceeded the posted limits of the bridge, so the driver was fined. The fact that there was no other way of reaching the village didn't help any!"

But these were heavy trucks, not buses of school children? True; but Mr. Colburn tells of seeing a bus-load of children, weighing far in excess of three tons, dash at 40 miles an hour over a bridge posted for exactly three tons and a speed of 15 miles an hour! Our introductory scene *can* happen—and will some day. Drawing on his experience, engineer Colburn says that an old structure "may safely carry a 20-ton truck today and collapse with a three-ton load tomorrow"; and cites the case of a steel bridge which fell in while a light coupé was crossing shortly after a heavy bus full of passengers passed over safely.

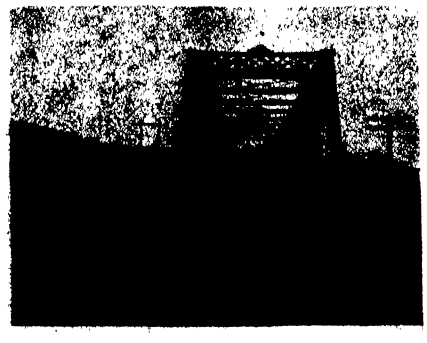
How much study has been given to this question? Little—too little! Mr. H. S. Fairbank of the Bureau of Public Roads, Department of Agriculture, writes: "I regret that there is at present no satisfactory information in this Bureau relative to the number and character of bridges on any of the public roads of the country. Realization of the need for such information is one of the reasons why we are now urging the States, with our aid, to make a thorough-going inventory of the existing rural highway facilities as a part of the state-wide highway-planning surveys, arrangements for which are being made in more than 35 States.

"When these inventories are completed, during the course of the present year, we shall have for the first time a reasonably adequate record of the highway bridges in existence in the States in which the work is done. At present there is no such record in any State, and the nearest approach to it that I know of is in Ohio."

The Highway Research Board, National Research Council, reports: "We regret that we have collected no facts and figures applicable . . ." Four representative state highway departments—those of the progressive states of New York, New Jersey, Illinois, and Connecticut—apparently have no pertinent records available. Connecticut, however, does make some attempt to tabulate highway accident causes. In that state motor vehicle fatalities numbered 439 in 1935; two were at bridge locations.

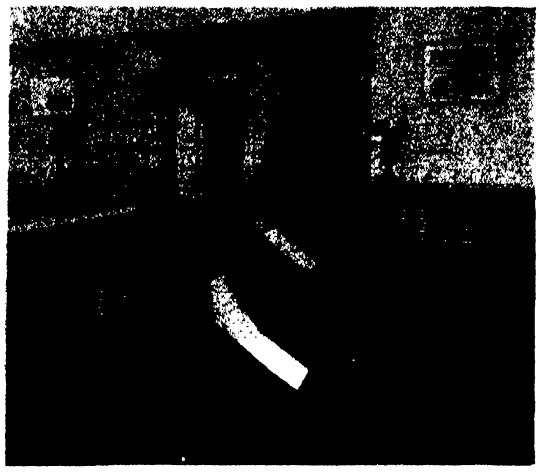


Obsolete, weak, narrow, poorly aligned bridges



Disabilities incurred at bridge locations probably ran much higher because in the country as a whole the ratio of disabilities to fatalities was 32 to 1.

Now, if these four states have so few data to offer, what of other, perhaps less progressive states? Assistant Traffic Engineer Donald S. Berry, of the National Safety Council, Inc., tells us: "We have some general statistics from a few of the states that show the relative importance of bridges as a factor in highway accidents. The following statistics from the states of Connecticut and Kansas will serve as examples:



Visible index system of bridge records, as kept by the Department of Highways of Ohio

"The annual report of the Motor Vehicle Department of the State of Connecticut shows that there were 439 motor vehicle fatalities in 1935. Of this number, there were 2 fatalities occurring at bridge locations. This seems to indicate that bridges are a small factor, although it must be remembered that the mileage of bridges is very small in comparison with the actual highway mileage."

ADDING to the facts concerning Connecticut, he says that of that state's 15,656 motor vehicle accidents, there were 155 occurring at bridge locations.

"The 1935 report of the Health Department of the state of Kansas," he continues, "shows that there were 52 motor vehicle fatalities occurring at bridges or culverts. The total number of motor vehicle fatalities during 1935 was 522. The statistics also showed that 49 of the 52 fatalities occurred as a result of collisions with fixed objects. This number is considerably higher than that in the Connecticut statistics which is probably due to the fact that the Kansas statistics include culverts with bridges.

"The foregoing statistics, however, do not give any indication of the effect of width or type of bridge upon the accident situation. The accident statistics which we get from the various states and cities do not show the number of accidents occurring on bridges of different widths, and accordingly, we have never been able to make a special study of this subject."

It is interesting to note here that the very complete "Accident Facts, 1936 Edition," published by the National Safety Council, makes no mention of the part played by bridges in the 11 deaths by accident and 1100 non-fatal injuries per hour in the United States during 1935.

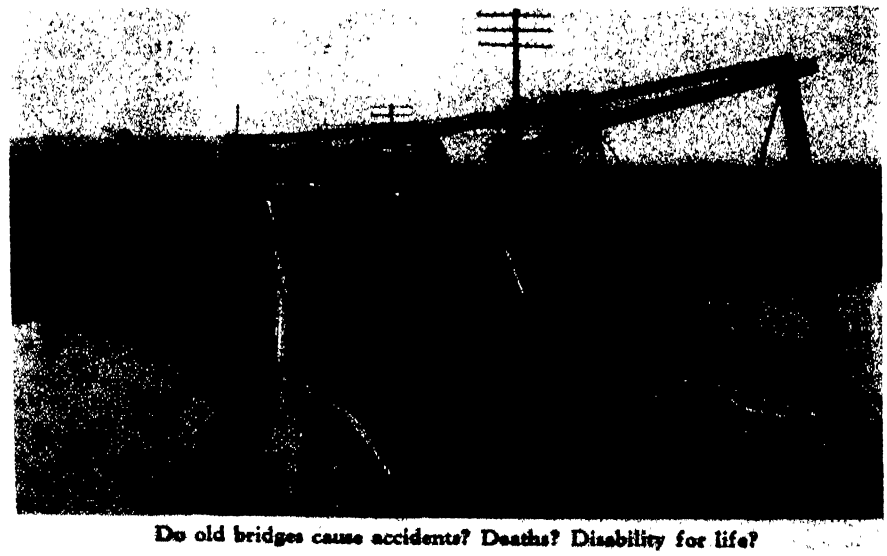
The claim files of The Travelers, Hartford, Connecticut, were equally unproductive of facts on bridge accidents. This was no doubt because their files are not so coded as to surrender their secrets without much research.

So far, we have noted a singular indifference to a problem admittedly significant. Generally speaking, bridges are of secondary importance in highway construction, as is indicated in a paper (Report of Committee on Highway Design) by Albin L. Gemeny, Senior Structural Engineer, U. S. Bureau of Public Roads. He says: "Legal restrictions on the vehicular loads which may be hauled over the public highways have been imposed by the various states of the Union. . . . Most of the regulations are intended to protect the highway pavements, little attention being given to the danger of destruction or serious overloading of bridges." Since his was a paper on design, he failed to mention the possible deaths coincident with bridge destruction!

A clue was given above, however, to one state which has been awake. This is Ohio, as representative and progressive a state as one could expect to find, with its interests in both farm and factory. Ohio has pioneered in making a commendably complete inventory of its bridges, their location, structural details and deficiencies, capacities, and the accidents that have occurred upon them. Mr. J. R. Burkey, Chief Engineer of Bridges of the Ohio Department of Highways, writes that he is fully in sympathy with the theme of this discussion, and has co-operated with us in its preparation, by supplying voluminous notes. For that co-operation, we wish here to express our appreciation as well as our regret that lack of space prevents quotation of as many of his facts as we should like to quote.

THE Ohio State Highway System now consists of 12,176 miles outside of municipalities, out of a total mileage in the state of 85,706. This total is to be increased this year by the addition of 5000 miles. By law, the State Highway Department is responsible for the construction, maintenance, and repair of structures on the system outside municipalities. In order to conduct this work efficiently the Department maintains an elaborate system of records in which the state is divided into 12 highway divisions for administrative purposes. A card index lists every structure on the State Highway System, the cards being filed in a visible index system in the same sequence in which the bridges occur on the road.

"Finger-printing" the highway bridges is what Ohio's card system does. The information is so complete and accessible that it is possible, by a quick glance, to tell what size and weight limits are imposed by structures on any given route. On a card no larger than eight inches by eight inches are shown a bridge's identification number, section, strength or safe load-carrying capacity, roadway width, roadway vertical clearance, type and approximate span of the structure, and numerous other engineering details as to structural fea-



Do old bridges cause accidents? Deaths? Disability for life?

All illustrations courtesy State of Ohio, Department of Highways

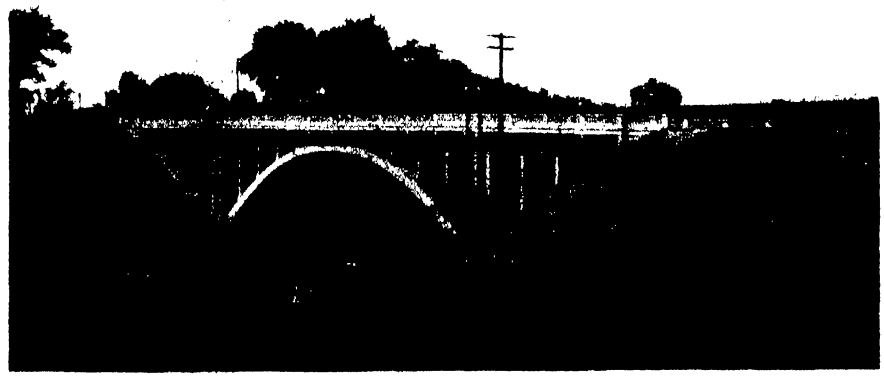
tures and characteristics. Bridges are inspected yearly and additional notes added to the card records.

Of great importance is the Department's classification of these bridges as weak, extremely weak, narrow, narrow and extremely weak, and other terms to show deficiencies.

The Traffic Bureau of the Ohio Highway Department has for several years past been making an extensive and detailed study of accidents on the highways, their causes and means of prevention, something which, as we have seen before, other states have not done in complete fashion—some, not at all. Last year, out of 9314 Ohio accidents reported, 161, or 1.7 percent, occurred on narrow bridges and culverts. Of 583 fatal accidents, 9, or 1.5 percent, occurred on narrow bridges. According to Mr. Burkey, probably many other accidents that did not occur *on a structure* were due to the congestion of traffic caused by a narrow or one-way bridge.

WE have cited the completeness of these records kept by Ohio, simply to point a moral. Other states, neglecting to study the serious menace of old, narrow, or badly aligned bridges, will do well to emulate Ohio's example. That state, in addition to the splendid record-keeping job, has also followed a definite schedule of replacement of obsolete bridges. In 1935, contracts were let for 56 bridges with a total length of 3700 feet, at a cost of approximately 1,000,000 dollars. To July 1st of this year, 47 were contracted for at a cost of more than 1,000,000 dollars. This, indeed, *is* a commendable record, but Mr. Burkey estimates that 35,000,000 dollars will be required to replace all the obsolete bridges on the present system.

This brings up the question of costs. We will turn, therefore, to figures supplied by Mr. A. J. Boase of the Portland Cement Association. He says that a typical 20-foot wide, two-lane highway built for heavy duty on primary state highways comprising the best type of materials and workmanship available today, and including grading, earthwork, and small culvert structures, will cost approximately $2.55 per square yard. "For intermediate construction on secondary roads," he says, "the corresponding cost is around 60 percent of that given for high duty types. For a high quality concrete bridge to carry this road on a span of around 50 feet, for example, the cost, including all incidentals, would be about 35 dollars to 55 dollars per square yard of usable deck surface, 45 dollars being a fairly good average value. This means that the bridge per unit of surface will cost about 17½ times as much as the highway." Thus is explained one reason why old bridges have been neglected: the engineers can show 17½ times as much highway for the same money. The desire has seemed to be to get a surface on all roads as quickly as possible and make them passable the year 'round. Roads have too often been located to make use of old structures, thereby sacrificing proper alignment and grades.



As rapidly as possible, some states are replacing obsolete bridges with structures such as these two in Ohio. Former bridges here were built for horse and buggy days; not for cars

TO quote Mr. Burkey again:

"Necessary bridge and road construction has had to be postponed in the last few years due to the diversion of funds raised for highway purposes—by gasoline taxes, registration fees, and other means—to relief and other governmental activities. (According to *The S. A. E. Journal*, 91,000,000 dollars of the money paid by motorists in special taxes was diverted last year to other than highway purposes.—EDITOR.) The injustice of this procedure is becoming more apparent to the motor vehicle users and the general public and it is hoped that the trend in the immediate future will be to restore these funds to their proper uses.

"The general practice of appropriations being made for highways, including bridges, with no provision made for the amount that shall be expended on bridges, works to the detriment of necessary bridge construction. This is due largely to the fact that the general traveling public quickly notices and complains about road conditions which slow up traffic or make traveling uncomfortable, whereas no complaint will be made about a dangerously weak bridge as long as it does not collapse." We hollered for better highways and got them. We permitted ourselves to be satisfied with new planks or blocks on the bridge floors and ignored what held them up.

One state, then, stands forth alone in this country in the completeness of her highway bridge records, and in her recognition of the fact that hundreds of these bridges constitute a menace to lives and property. Ohio has fought the problem through logically and frankly, confessing her failures, and doing her best to remedy them. Other states, by comparison, have been extremely backward—some criminally negligent! No matter where the fault *apparently* lies. Actually, each entire state as a whole is responsible for forgetting her dangerous bridges. The states themselves—officialdom and public alike—must take the situation in hand, study it through as Ohio has done, and apply the remedy as rapidly as possible. If they do not, there is certain to be a steadily mounting toll of lives as these forgotten bridges grow older, and the economic loss will pile up to enormous totals.

Bridges are not separate entities. They are as much a part of the highways on which they lie as are the road surfaces. They possess no special merit entitling them to discriminatory *laissez-faire* treatment. Indeed, since they are, at best, fixed objects seeming to invite collision, and, at the worst, potential death-traps, perhaps more attention should be paid to them than to adjacent highways. Only when the country realizes the fact that "horse-and-buggy" bridges are not compatible with safety will the road factor in the accident problem be on its way to a final solution.

UP TO DATE ON

Efforts to Piece Together the Biggest Present Puzzle of Physical Science Go On . . . Part of the Picture Emerges but Much Remains a Deep Mystery

THE past twelve months and the next to come may well be marked in science texts of the future as the crucial period in the development of cosmic ray theory. Within the last year the controversy over the nature of cosmic rays has resolved itself into a more or less general agreement. What the next will bring remains to be seen; but indications are that at least some of the outstanding mysteries should be cleared up. So much cosmic ray research is being done all over the world that the scientific journals are continually crowded with accounts of new experiments and measurements.

But why so much interest in a phenomenon which is so far lacking in practical applications? These rays go whizzing around and about us with incredible energies, but without any obvious effect or any way, obvious or otherwise, of being harnessed to do work. Well, the answer is partly man's natural-born curiosity to know what makes the wheels go round; and partly that, when we find out all there is to know about cosmic rays, we shall know a great deal more about how the universe behaves, from the stars right down to individual atoms. We might then be able to produce cosmic rays artificially, as we do X rays, and there is no telling what an ingenious scientist might do with so powerful a tool in his hands.

Cosmic rays have the universe for their playground. They pour into the earth's atmosphere from all directions at once, and there is every indication that they pervade all interstellar space. They come apparently from nowhere, and speed along their way, like Sunday drivers, with nowhere in particular to go.

ORDINARILY they travel in straight lines, like light, and indeed, for a long time cosmic rays were thought of as being a high-energy wave or photon radiation similar to light and X rays. But within the last few years experimental evidence has been piling up to show that they cannot be photons at all.

For when a fairly low-energy ray comes within reach of the earth's magnetic field, it departs from its straight line path and curves in toward the earth's magnetic poles (Figure 1). Only rays of very high energy, more than 20 billion electron volts, can go vertically through the atmosphere at the equator. So if we take an instrument to measure the number of rays reaching sea level per minute, we shall find more coming in in the higher latitudes, nearer the earth's magnetic poles, than at the equator. This increase in intensity as one goes north or south from the equator is known as the latitude effect. It was discovered by Clay in 1927, and has since been amply verified by Compton, Millikan, and many others.

The latitude effect at sea level is not very great, but if we took our cosmic ray counters up in an airplane, as Bowen, Millikan and Neher have done, or in a stratosphere balloon, we should find the variation much more pronounced. At the very top of the atmosphere, the polar intensity is probably more than a hundred times greater than the intensity at the equator.

Figure 1: **How the earth's magnetic field deviates arriving particles. From Lemon, "Cosmic Rays Thus Far," courtesy W. W. Norton & Co.**

These facts take some explaining. We know that the rays we measure are deflected by the earth's magnetic field. Such behavior would be inexcusable in a photon, which is able to traverse a magnetic field as if it were not there at all. An electrically charged particle, on the other hand, behaves in a magnetic field just as these rays do, and we must conclude, then, that what we are measuring are streams of charged particles like electrons, positrons, and protons.

But are the rays we measure the real cosmic rays? Suppose for a moment that the original ray is a stream of photons instead of charged particles. Once inside the atmosphere it begins to collide with the molecules and atoms of the air, breaking them up into fragments. These fragments are charged, and they become a secondary cosmic ray.

This theory fits all the facts but one, and that is the rapid increase of the latitude effect with altitude. If the rays we are measuring are entirely secondaries, we should expect to find fewer of them near the top of the atmosphere, where atoms and molecules are few and far between. Here the latitude effect should drop off. Apparently, however, it goes right on increasing as far as the magnetic field is effective.

These are the pieces of the puzzle, and when we fit them together we find we must conclude that at least the greater part of the original cosmic ray consists of charged particles. Photons, neutrons, and any other neutral corpuscles are confined, if indeed they are present at all, to a tiny fraction of the incoming radiation.

HAVING decided this, we can immediately put it to use. The rays are sensitive to all irregularities in the earth's magnetic field, an inconveniently lopsided and unsymmetrical affair. If across a map of the world we draw lines through all the places where equal intensities of cosmic rays occur, we have a series of curves or "isocosms" following almost exactly the lines of equal magnetic force. So in cosmic rays we have a new means of studying the magnetism of our own planet.

The last opponent of the charged particle theory of cosmic rays has fallen by the wayside within the last year, so we can turn now to see what other bones of contention we can unearth. For the discovery that the rays are chiefly charged particles is only half a triumph. We have still to find out what the particles are, what they do, and whence they come.

There is a large class of charged bodies. The lightest of these are the electron and the positron, or positive electron. Then comes the proton, the elementary positive corpuscle which forms the hydrogen nucleus. Next heaviest is the deuteron, the core of heavy hydrogen, with the same charge as the proton but weighing twice as much. Next in line is the helium nucleus or alpha particle, with a charge of two and a mass four times that of the proton. After these come a long series of atomic nuclei or ions, each heavier and bearing more charge than the one before.

Cosmic Rays

By JEAN HARRINGTON

Out of these, which particular particles are pouring into our atmosphere as cosmic rays? In other words, how can we identify and analyse streams of bodies which we cannot see nor feel? Such is one of the most important problems of current research.

Imagine for a moment that we can divide a stream of cosmic rays into several distinct groups: a group of alpha particles, say, another of protons, and so on. Taking one of these groups separately, let us see what happens to it as it approaches the earth in any particular latitude. It has been mentioned before that a particle must have tremendous energy to get through the atmosphere at the equator. It is also true that it must have a certain minimum energy in order to penetrate the atmosphere at all; otherwise it will simply be deflected so much that it retreats off into empty space before it has a chance to reach the air. Now the particles in any group have many different energies, some less, some greater, and some just equal to this minimum or "critical" energy of penetration.

WHAT happens to the particles of critical energy or greater as they hit the air? They crash into atoms and molecules in their way, and at each encounter lose some of their original energy, until finally they come to a standstill and cease to be rays at all. The distance they travel before they lose all their energy is called the range of the particles. Those with the same energies have equal ranges; and those with the lowest possible or critical energy obviously have the shortest ranges. We can calculate what this minimum range should be for any kind of particle with critical energy. The next step is to compare the calculations with the actual experimental facts.

Piccard, Captain Anderson, and others who have made stratosphere balloon flights have brought back from the heights of the atmosphere records of the cosmic ray intensity. We have said that the intensity goes on increasing steadily up to the top of the air, but this is not quite true. For suppose the balloon reaches the heights where one group of particles with critical energy has just reached the end of its range. Here the instruments will record a certain intensity, based on the number of ions produced by the original particles. Then if the balloon goes still higher, there is no increase in intensity, because there are no more of these particular particles of shorter range to give any additional ionization in the instruments. So if a graph is drawn showing how the intensity increases with altitude, there are flat steps in it at the heights where the various minimum ranges belonging to different types of particles come to an end.

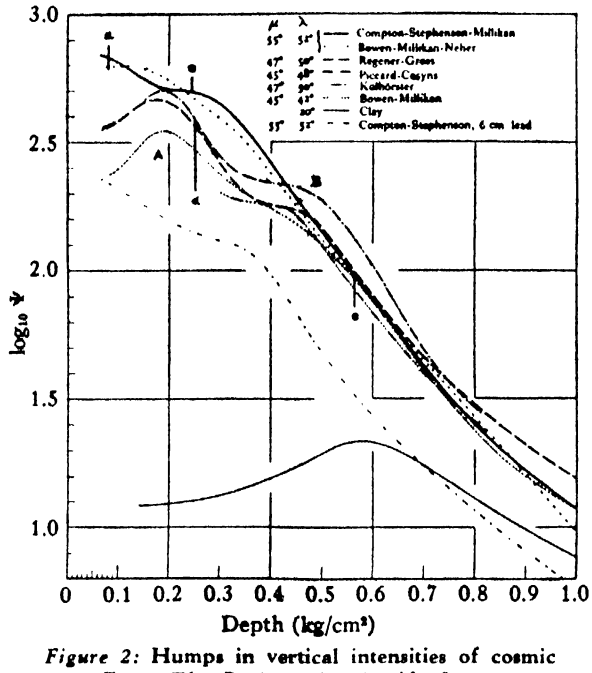


Figure 2: **Humps in vertical intensities of cosmic rays. From *The Review of Scientific Instruments***

As a matter of fact, the graphs plotted from actual observations show three such steps, one very high in the atmosphere, one near sea level, and a third falling in between (Figure 2). A beautiful verification of these results was presented at the May meeting of the American Physical Society by Dr. W. F. G. Swann, when he showed the observations made on the historic stratosphere flight last November.

Now, comparing the calculated range of an alpha particle of critical energy with the range indicated by the topmost step, we find that they agree remarkably well. So we conclude that one component of cosmic radiation consists of alpha particles. Similarly we discover that the range of electrons and positrons accounts for the middle step, and that the lowest step is due probably to protons.

There are, then, three chief components of cosmic rays that we can be pretty sure of: alpha particles, found only high in the stratosphere, electrons and positrons which are more penetrating, and protons, the most penetrating of all. We are not justified in saying, however, that these are the only components. For if a stratosphere balloon got beyond the 72,000 feet reached by Captain Anderson in November, it might reveal other steps due to the ranges of particles heavier than the helium nucleus. There may also be neutral particles, like photons or neutrons, with even greater ranges than the proton; but these, if they occur at all, form so small a fraction of the total radiation that they do not show up in the experimental curve. Very probably there are no other charged particles with a minimum range greater than protons, unless there is some very penetrating body still unknown to science.

IT should be noted that, in comparing the observed ranges with those calculated, we must reduce them to the same terms. For a particle with a given energy will travel much farther in the rarefied gas of the stratosphere than it will near sea level where it encounters many more atoms and molecules per centimeter of path. One must compute what depth of stratosphere air is equivalent to a unit volume of air at ordinary pressure in order to make any comparison. There is still a great deal of uncertainty in making these calculations, because it is not known to any degree of exactitude just how or how fast the rays lose energy in going through the air.

An interesting verification of the presence of alpha particles in the upper atmosphere was reported to the American Physical Society recently by T. R. Wilkins of the University of Rochester. His, he claimed, was the simplest equipment to be sent up in the National Geographic-Army Air Corps stratosphere balloon. It consisted only of a set of specially prepared photographic plates attached to the outside of the gondola. Any particle which happened to glance across one of these plates at the right angle would leave its characteristic

track in the emulsion. Although the thorough examination of the plates is a long and tedious operation, those already studied show long, heavy tracks due to high energy alpha particles. No trace of other particles has yet been found.

Electrons and positrons have also been observed in Wilson cloud chamber photographs. But no one, up to the time this paper is being written, has yet succeeded in definitely cornering a cosmic ray proton, by cloud chamber photographs or otherwise. At best we can say that the data gathered so far seem to point to protons as the third chief group of cosmic ray particles; and by the end of the year there may no longer be any uncertainty about it.

One of the many effects of cosmic rays, the most interesting and the least understood, is the production of showers of charged particles. A cloud chamber photograph (Figure 3) of a shower shows a sheaf of dozens of tracks all originating from the same point, and curving in the magnetic field of the chamber, some more than others, some to the left, others to the right. The interpretation of such a photograph is that large numbers of positive and negative electrons of different energies are produced almost simultaneously by a single cosmic ray encounter. The negative electrons are deflected in one direction by the magnetic field, while the positrons are curved in the opposite way. Those of lower energies have the shorter and more curved paths.

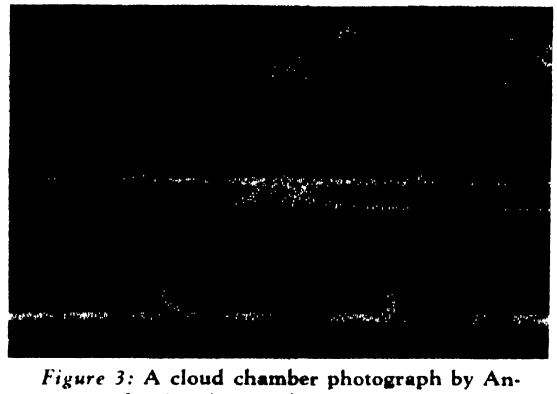


Figure 3: **A cloud chamber photograph by Anderson, showing dozens of cosmic ray tracks curved, as explained in the text, by the magnetic field**

THE particle responsible for these atomic cataclysms is very probably a photon. This seems a bit absurd, as we have already devoted a page or two to proving that photons can have but an inappreciable place in cosmic radiation. True, but we were talking then about those pristine rays which come through space just as they were created. What reaches us and what our instruments record may be only fourth or fifth cousins of the original family. For a whole series of things may happen before the energy in one of those primary rays is dissipated.

We think of an atom as a heavy nucleus surrounded by a number of electrons. Suppose one of the cosmic ray particles runs into such an atom in the atmosphere, as we have pictured it doing several times before. One of two things may happen. It may knock an electron from its place outside the atom, leaving the atom as a charged ion and sending the electron along as a secondary ray. This is the process of direct ionization, and we believe that the proton is most efficient at this type of encounter.

Or the cosmic ray particle may penetrate clear to the nucleus, causing profound energy changes therein, changes resulting in the emission of some nuclear particle or radiation, in turn giving rise to an X-ray photon. Now this photon can lose its energy in producing an electron and positron; these smash into other nuclei to bring forth new photons, which in the course of events create new electron pairs, and so the cycle progresses until the energies involved become too low to be effective. Long and complicated as such a process seems, it occurs practically instantaneously in a region where gas molecules are crowded closely together, as they are in a cloud chamber.

So in this second process of cosmic ray encounters is a possible explanation of the showers. The theory that the photon starting a shower is probably a secondary is supported by the fact that showers follow the same variation in latitude as the original rays; that is, more occur at higher latitudes than near the equator.

One well-established but not too well-explained observation is the rapid increase in the number of showers per minute with increasing altitude. The growing intensity of the original cosmic rays themselves as one goes higher in the atmosphere accounts for a part but not all of the increase. It has been shown experimentally, however, that the shower-producing photons are excited primarily by electrons and positrons, and there is a theory of Bethe and Heitler, based on wave mechanics, to back up the experimental results. We remember that positive and negative electrons are less penetrating than protons, and thus occur in relatively larger numbers high in the atmosphere. If we could prove that the increase in the number of electrons and positrons alone with altitude coincides with the increase in showers, our problem would be solved.

However, Dr. Millikan, the old antagonist of the charged particle theory of cosmic rays, and still partial to his photons, has recently made some shower measurements on the top of Pike's Peak. He found that the increase in showers at that altitude was much larger than the relative increase of electron intensity. On that basis he proposes that some of the showers must be caused by primary rather than secondary cosmic ray photons. This could mean that the fraction of incoming photons must be considerably larger than most scientists are willing to admit. Although Dr. Millikan's results were questioned at the time he made his report, there are many such inconsistencies and uncertainties still to be cleared up.

NOW a word about the energies of cosmic rays. The chief experimental method of determining the energies of charged particles is based on the property we have mentioned many times before; namely, their deflection in a magnetic field. One difficulty with this method lies in deciding which of the particles are primaries and which secondaries; another is that particles with energies higher than four or five billion electron volts are affected so little, even by the strongest magnetic fields that we can produce, that it is impossible to measure the curvature of their tracks accurately. But other considerations, based on the theory of penetration and on measurements of the great depths beneath the surface of the earth which some of the rays manage to reach, indicate energies ranging roughly from a billion to perhaps more than 600 billion electron volts. These are much higher values than were accepted last year, since in the interim scientists have come to agree that the particles of lower than a billion volts energy are, in general, secondaries.

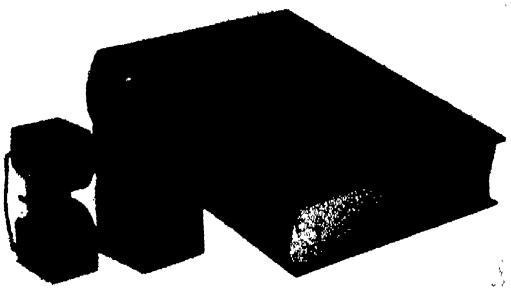
While our knowledge of the laws of absorption of high-energy particles passing through matter is still more qualitative than accurately quantitative, and most of our calculations therefore only approximations, we can say that the energies of the original cosmic rays are so great as to be almost beyond human imagination. But where do these particles acquire such inconceivable speeds? This is a question we must leave for the future. At present the hypotheses concerning the birth of cosmic rays are at best wild guesses. The rays seem to come from beyond the solar system, and from far beyond the island universe of stars and nebulæ in which our own little system lies embedded. Probably the rays have been traveling through empty space for billions of years before they reach us. But where they started from, and why, neither Compton nor Millikan, nor Swann nor any other cosmic ray expert can yet tell you.

Microscopic Big Books

Books, Documents, Drawings, Newspapers on Tiny Film Read in Projector . . . System Saves Handling of Originals . . . Enlarges Libraries . . . Many Uses

By R. G. SKERRETT

THE crowded contents of a large library can now be duplicated on a microscopic scale and yet rendered optically available, when desired, on even a somewhat magnified scale for the greater convenience and comfort of the reader. This has been made possible by cameras of special kinds, by films of superfine grain, and by recently developed reading machines of light and compact forms that enlarge and project the recorded micro-copies. Thus we have a significant advance over the method, first used some years ago, of making a film record of pages of rare books so that the books themselves might suffer less destructive handling.



A monster reference book is reduced to a film sealed in the case (with box) shown at left

The question of space in the library, in the office, and elsewhere is yearly becoming increasingly acute, because suitable space costs more and more and involves complications. By the use of the new method, printed pages, drawings, music, current files, and the like can be reduced to microscopic size and reproduced for reading or examination with a great saving in weight and bulk.

Work in this field has been going forward abroad and in this country for years, but much has been accomplished lately in this country to make the benefits of micro-copying available to the greatest number of people. By means of micro-photography an original full-size page can be reduced from 150 to 400 times, registered well-nigh imperishably on specially treated films, and then encased in sealed cartridges ready to be inserted in a suitable magnifying reading machine. A pound of film will carry micro-copies that are the equivalent of a ton of printed matter in the usual form, altering to that degree the whole problem of storage, handling, and distribution.

Heretofore, micro-copying of books and the like has mainly been utilized by the scientific and the academic world. Now, many more people will be able to benefit by this medium of reproduction. Original volumes and documents, virtually museum pieces, need not be handled by the reader in their original form, and accessibility restrictions will, in effect, be lifted by placing the photographic films at the disposal of any responsible person who would be able to obtain from a library the loan of any ordinary volume. The cultural benefits of the new procedure should be self-evident. Furthermore, should an original be destroyed, after micro-copying, then the film would still remain as a source of information and duplication.

It is now the practice of some newspapers to make film record copies of their daily issues instead of printing special issues on rag paper. A number of universities are using the same method to film rare books and manuscripts to amplify the resources of their libraries. Several government departments are pursuing a similar course to preserve valuable publications and to assist isolated scientific workers, educational institutions, organizations and individuals. This is notably the case with our Department of Agriculture. There are banks that thus record daily all the checks that pass through them. Ordinary industrial and commercial correspondence can be reduced to film file records and save in office space and possibly in rented storage space.

The film's tiny "pages" are projected on the screen of this device

The pioneer inventions of Rear Admiral Bradley A. Fiske, U.S.N., in the field of reading machines and the more recent inventions of Verneur E. Pratt are combined in the apparatus produced in the last few months for making and then projecting micro-copies of all kinds of printed matter. The so-called "filmbook" is a film packed in a cartridge or holder in a manner that does not expose the emulsion side of the film to possible marring. In handling the filmbook, the fingers never touch the film, and the container can never be placed in the reading machine inverted. These arrangements insure long service life of the film. The Teledex is a line-reading model to be used with filmbooks of telephone directories and similar volumes, as well as statistical data and the like; and the Optigraph is a reading machine of unrestricted scope.

A LAWYER, a physician, a patent attorney, an engineer, and so on may have at his disposal in his own office in an extremely compact form an entire library relating to his particular profession. Small towns and schools may be able to house filmbook copies of the entire contents of a large metropolitan library. The filmbook method may be employed in reproducing reference books, dictionaries, encyclopedias, and other generally bulky volumes, and do so for a fraction of what the present editions of such works cost. When not in use, the filmbooks can be tucked away in a very small space. Inventive minds, by these unique uses of the camera and the photographic film, have thus opened the way to still more astonishing applications for the benefit of one and all.

NOVAE AND SUPER-NOVAE

The New Star Recently Discovered Lies in Our Own Galaxy and is a Normal Type . . . Some Seen in Other Galaxies Are Enormous . . . Called Super-Novae

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society.

IT is still news as these lines are written—though it will hardly be when they are published—that still another bright temporary star has appeared. This one was discovered on June 18 by L. C. Peltier of Delphos, Ohio, the active amateur who recently detected the comet which is likely to be visible though not conspicuous to the naked eye about August 1. The star was then of the third magnitude.

Good evidence of how close a watch is now kept upon the heavens is found in the fact that the Nova was independently discovered by Nielsen in Denmark, Loreta in Italy, and by four others at Sonneberg and Heidelberg in Germany, Stalinabad in the Soviet Union, and Kalamazoo, Michigan. The only remarkable feature of this is that one of the discoverers, Hoffmeister of Sonneberg, is a professional astronomer! Most professionals are too busy looking through telescopes or, more probably, guiding eyepieces, to gaze upon the sky at large.

There were many professional astronomers and very competent ones in the 19th Century, but the skilled and competent amateurs of today were rare then. This may explain an apparent puzzle. The present Nova is the sixth since 1900 which has become conspicuous to even a casual glance, and the second, Nova Geminorum of 1912, surpassed the fourth magnitude and was easily visible to the naked eye even under poor conditions. That is, we have had a naked-eye Nova every five or six years. Yet only three such objects, none of them very bright, were recorded in the last half of the 19th Century. Is this merely an accident such as well may happen with something that occurs at irregular and unpredictable intervals? Or are the heavens better watched than formerly? We can be certain that no object like Nova Persei, which was at best as bright as Vega, and Nova Aquilae, twice as bright, appeared between 1850 and 1900—unless, indeed, it blazed up in the part of the heavens close to the sun and faded again before the sun had got out of the way. There is one chance in three or four that this would happen. Setting these two aside we have three in 50 years against four in 36, which is no larger a fluctuation than is very likely to come by chance.

So we cannot be sure how much of the present abundance of recorded Novae is to be attributed to the diligence of modern observers and how much to the casual bounty of Nature. We know for certain, however, that the amateur's careful watch has resulted in the discovery of recent Novae at an early stage of their career, and so made it possible to secure observations of great importance which would otherwise have been lost forever.

The new discovery will be known as Nova Lacertae, since an exact determination of its position shows that it lies a fraction of a minute of arc from the boundary between this constellation and Cepheus—to which it was at first accredited. This is a good example of the utility of the exact delimitation of the constellations, which was reported in these columns a few years ago.

OWING to precession, the declination of this star is increasing and if the constellation boundaries were supposed to move with the pole and equinox, it would now be in Cepheus. But the boundaries are fixed in terms of the equinox of 1900, so no such absurdity can arise. Proper motion might really carry the star across the line, and it is lucky that it is not double for we might then have an astronomical analogue of the story of the man whose house was in Massachusetts, but his back yard and garage in Rhode Island, so that he had to pay for car licenses in both states.

The Nova itself appears to be of the normal type like Nova Aquilae. It rose to maximum at magnitude 2.3 on June 20 and has dropped rapidly. Van Beisbroeck reports that it is probably identical with a 15th magnitude star which appears in photographs between 1893 and 1930. Its spectrum just before maximum showed dark lines displaced to the violet, indicating a velocity of 1100 kilometers per second. This is a high velocity even for a Nova, and suggests that the outburst was a great one and that the star is remote. Struve's statement that there are strong interstellar calcium lines confirms this suspicion. A reliable determination of the distance may some day be made if an expanding nebula around the star becomes telescopically observable, but this may require years.

Not long before this conspicuous star absorbed the attention of observers, a faint but really far more remarkable Nova was recorded in a spiral nebula. The appearance of new stars in extragalactic nebulae is by no means unprecedented. A new star appeared in September, 1885, close to the center of the great Andromeda nebula, and rose to magnitude 7.5. Had modern spectroscopic equipment been available a great deal could have been found out, but in those days only visual observations could be made and those were indecisive. A Nova, Z Centauri, appeared later in a southern spiral nebula, and no less than five of these objects were observed in nebulae belonging to the great Virgo cluster between 1909 and 1926. Spectrum photographs of Z Centauri and of one of the others were obtained, but were again hard to interpret conclusively owing to the very small scale.

A watch has been kept at Mount Wilson for similar objects, and was rewarded in January of the present year when a star of magnitude 14.5 was observed by Hubble and Moore in the spiral nebula N.G.C. 4273, where nothing had been visible three weeks before. In a month it had faded to a quarter of its original brightness, confirming the diagnosis of a temporary star.

These figures do not appear at first sight to be remarkable, but this nebula is very far away. The distance to the middle of the cluster to which it belongs is estimated by Hubble, on very good evidence, as 7,000,000 light-years. To appear of the 14th magnitude at that distance the Nova must have been 8,000,000 times as bright as the sun! There is good reason for the name "Super-Nova," which is now generally accepted.

The star in the Andromeda nebula must have been brighter still. The distance of this is well determined as 900,000 light-years and the correspond-

ing maximum brightness is 60,000,000 times the sun's. These are amazing figures but there is a direct check on the last and wildest; for large numbers of much fainter Novae have been observed in the same nebula. These are fairly similar in maximum brightness and, with the same assumption regarding the distance, they come out from 5000 to 100,000 times as bright as the sun. These are almost exactly the limits which are found by altogether independent methods for the bright Novae which can be studied in full detail.

THIS is convincing evidence but, nevertheless, how can a single star give out many times as much light as all the stars visible to the naked eye?* Two ways are open: it may be very big or very hot. Without knowledge of the spectrum we could do no more than speculate. But Humason, with the 100-inch reflector and the new and very powerful nebular spectrograph (which gives tiny images but can reach very faint stars), photographed the spectrum of this latest Super-Nova in February, 1936 (when it was of magnitude 15.7!!) and obtained a plate which shows definite details. The spectrum at first sight looks queer enough but, when compared with those of other Novae, it becomes intelligible. The principal features are enormously wide, though not very intense emission bands which may be interpreted as the hydrogen lines Hβ and Hα, and a group of nitrogen lines in the blue (near 4650) all prodigiously expanded to a width of from 150 to 200 angstroms. These are just the lines which are strongest in some typical Novae of the ordinary sort, but to widen them to this extent demands a shell of gas expanding with a velocity of 6000 kilometers a second.

A faint spectrum of a Super-Nova in another nebula, obtained at Mount Wilson by Nicholson in 1926, is strikingly similar, and Mrs. Gaposchkin at Harvard had independently shown that the photographed spectrum of Z Centauri was of the same character. As for S Andromedae, the verbal descriptions of visual observers, which alone are available, are consistent with a spectrum of the same sort. It appears, therefore, that the spectra of Super-Novae differ from those of ordinary Novae mainly by exaggeration of these remarkable features—the bright bands widening so greatly that only the stronger ones are saved from merging into a general confusion. Physically this suggests that the outburst of a Super-Nova differs from the ordinary kind mainly in its intensity. The shell of ejected matter is blown off many times faster. In the same number of days it travels correspondingly further, so we might well expect Super-Novae to be much greater in diameter than ordinary ones at comparable dates. Whether they are brighter per square mile as well is harder to tell, but Mrs. Gaposchkin in a very recent paper points out that the great strength of the blue nitrogen lines in ordinary Novae indicates a relatively moderate degree of atomic excitation which is surpassed in other cases. If, following her lead, we assume that at maximum a Super-Nova shines ten times more brightly per unit of surface than the sun, the surface area of S Andromedae comes out 6,000,000 times the sun's and its diameter about 2500 times the sun's, rather larger than the orbit of Uranus. The recently observed star, on the same assumptions, would be about one third as big, or three times the size of a giant star like Antares.

L. C. Peltier in his home-made observatory. Many notable discoveries have been his

There is nothing absurd about these dimensions, particularly when we recall that they are those of the expanding shell of gas at the time when it begins to become transparent and let through the ultra-violet light from the central core. At 6000 kilometers per second the shell would expand to 750 times the sun's diameter in a single day. It might easily keep on for two or three days before it grows thin, depending on the amount of material which was originally blown off the star. So this hypothesis appears to be quite reasonable.

A Super-Nova must get rid of an enormous amount of energy. If it remains of 60,000,000 times the sun's brightness for a month, it would lose as much visible radiation as the sun does in 5,000,000 years. How much more escapes in the ultra-violet (unobservable through our atmosphere) we do not know—some allowance has already been made for it by overestimating the duration of maximum brightness. Measured in engineering units the amount of energy is great beyond conception. From the cosmogonic standpoint it is not so high. The store of internal energy which the sun possesses in virtue of its huge internal temperature is about three times as great, and a dense massive star would contain much more. It is possible, therefore, to explain even a Super-Nova on Milne's theory that some growing approach to internal instability breaks down with a sudden contraction of the central mass of a star, liberating a tremendous store of heat. It may be, however, that in these vastest of all known energy-transactions a wholesale liberation of sub-atomic energy occurs. We must wait for further data—and perhaps wait a long time—before we can decide.

IF Super-Novae appear in external galaxies, why may they not in our own? It is likely enough that one has actually been seen. Tycho Brahe in 1572 carefully observed a Nova in Cassiopeia which became brighter than Venus and was visible in broad daylight. He observed its position within a fraction of a minute of arc, without the aid of the telescope! There is nothing near this place now which can be connected with the Nova. Had it been an ordinary Nova, it would have had a large parallax. Assuming it to have been a Super-Nova we get a distance of about 2000 light-years, which is reasonable enough.

Stranger perhaps than all else is the thought that in the phenomenon of Super-Nova—which we date naturally by the time at which we see them—we are studying specific transitory events which happened not a few centuries ago in historic times but in the geologic past before the Ice Age had begun and when no intelligent life inhabited our planet. —*Princeton University Observatory, July 6, 1936.*

●

¶ *Few amateur or professional astronomers have ever known the skies better than Leslie C. Peltier, whose vocation is that of a draftsman but who spends the greater part of his free time in the avocation of variable star observing and the search for comets and new stars; in fact few professional astronomers have the opportunity to become* thoroughly *familiar with the appearance of each detailed constellation.*—Ed.

*There are about 6000 such stars. If they average 100 times as bright as the sun, their total light is 1 percent of that of S Andromedae, but allowance for very bright stars like Rigel or α Cygni would increase this total.

LIQUID-PROPELLANT ROCKET

Gyroscopic Control... Speeds of 500 and Then 700 Miles per Hour Attained... The Next Step Toward Higher Speeds and Elevations is Weight Reduction

(In Two Parts—Part 2)

ALTHOUGH much of the eastern part of New Mexico appeared to be suitable country for flights because of clear air, few storms, moderate winds, and level terrain, it was decided to locate in Roswell, where power and transportation facilities were available.

A shop 30 by 55 feet was erected in September 1930 (Figures 5 and 6), and the 60-foot tower previously used in Auburn and Fort Devens was erected about 15 miles away (Figure 7). A second tower, 20 feet high (Figure 8), was built near the shop for static tests; that is, those in which the rocket was prevented from rising by heavy weights, so that the lift and general performance could be studied. These static tests may be thought of as "idling" the rocket motor. A cement gas deflector was constructed under each tower, as may be seen in Figures 7 and 8, whereby the gases from the rocket were directed toward the rear, thus avoiding a cloud of dust which might otherwise hide the rocket during a test.

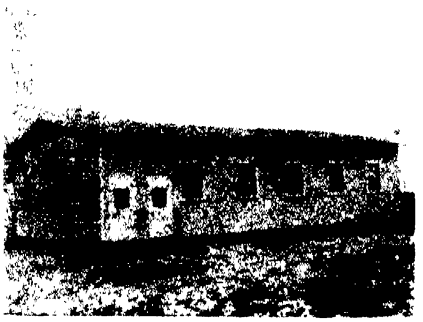


Figure 5: **The shop which was erected in Roswell, New Mexico, in 1930**

Figure 6: **Interior of the shop at Roswell, with its several machines**

Although, as has been stated, combustion chambers had been constructed at Clark University which operated satisfactorily, it appeared desirable to conduct a series of thorough tests in which the operating conditions were varied, the lift being recorded as a function of the time. Various modifications in the manner of feeding the liquids under pressure to the combustion chamber were tested, as well as variations

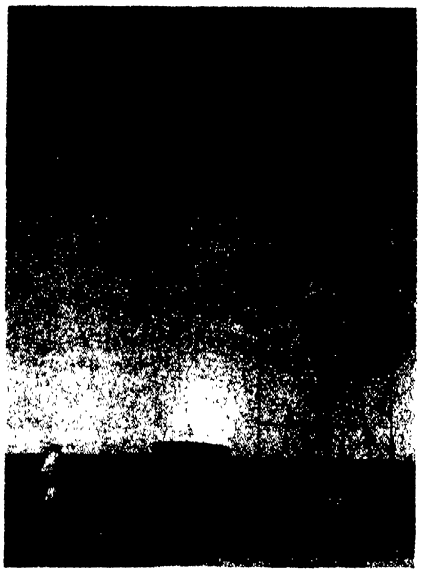


Figure 7: **The 60-foot tower that was previously used in the North**

in the proportions of the liquids, and in the size and shape of the chambers. The chief conclusions reached were that satisfactory operation of the combustion chambers could be obtained with considerable variation of conditions, and that larger chambers afforded better operation than those of smaller size.

As will be seen from Figure 8, the supporting frame for the rocket was held down by four steel barrels containing water. Either two or four barrels could be filled, and in the latter case the total weight was about 2000 pounds. This weight was supported by a strong compression spring, which made possible the recording of the lift on a revolving drum (Figure 9) driven by clockwork.

The combustion chamber finally de-

Figure 8: **The 20-foot tower near the shop, used for the static tests**

cided upon for use in flights was $5\frac{3}{4}$ inches in diameter and weighed five pounds. The maximum lift obtained was 289 pounds, and the period of combustion usually exceeded 20 seconds. The lifting force was found to be very steady, the variation of lift being within 5 percent.

The masses of liquids used during the lifting period were the quantities most difficult to determine. Using the largest likely value of the total mass of liquids ejected and the integral of the lift-time curve obtained mechanically, the velocity of the ejected gases was estimated to be over 5000 feet per second. This gave for the mechanical horsepower of the jet 1030 hp., and the horsepower per pound of the combustion chamber, considered as a rocket motor, 206 hp. It was found possible to use the chambers repeatedly.

THE results of this part of the development were very important, for a rocket to reach great heights can obviously not be made unless a combustion chamber, or rocket motor, can be constructed that is both extremely light and can be used without danger of burning through or exploding.

The first flight obtained during this period was on December 30, 1930, with a rocket 11 feet long, weighing 33.5 pounds. The height obtained was 2000 feet, and the maximum speed was about 500 miles per hour. A gas pressure tank was used on the rocket to force the liquid oxygen and the gasoline into the combustion chamber.

In further flights pressure was obtained by gas pressure on the rocket,

DEVELOPMENT

By ROBERT H. GODDARD
Director of the Physics Laboratory at Clark University

and also by pumping liquid nitrogen through a vaporizer, the latter means first being employed in a flight on April 19, 1932.

In order to avoid accident, a remote control system was constructed in September 1931, whereby the operator and observers could be stationed 1000 feet from the tower, and the rocket fired and released at will from this point. This arrangement has proved very satisfactory. Figure 10 shows the cable being unwound between the tower and the 1000-foot shelter, the latter being in the far distance, and Figure 11 shows the control keys being operated at the shelter, which is provided with sand bags on the roof as protection against possible accident. Figure 10 shows also the level and open nature of the country.

One observer was stationed 3000 feet from the tower, in the rear of the 1000-foot shelter, with a recording telescope (Figure 12). Two pencils attached to

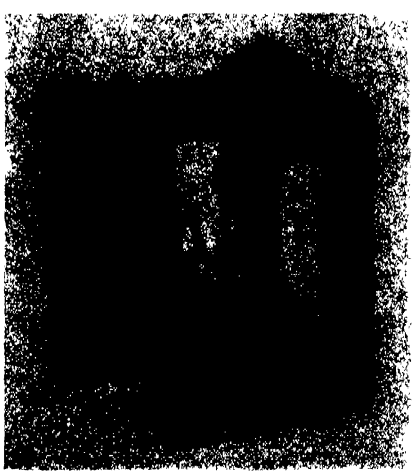


Figure 9: **Revolving drum for recording the lift in the static tests**

this telescope gave a record of the altitude and azimuth, respectively, of the rocket, the records being made on a paper strip, moved at a constant speed by clockwork. The sights at the front and rear of the telescope, similar to those on a rifle, were used in following the rocket when the speed was high. In Figure 13, which shows the clock mechanism in detail, the observer is indicating the altitude trace. This device proved satisfactory except when the trajectory of the rocket was in the plane of the tower and the telescope.

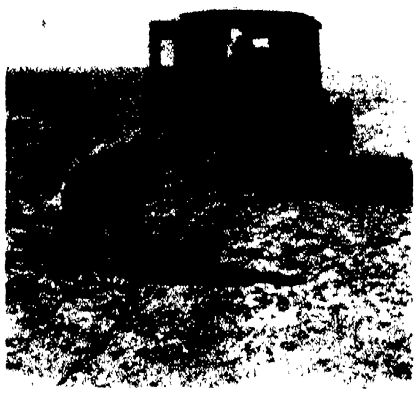


Figure 10: **Cable being unwound between the tower and the shelter**

For great heights, short-wave radio direction finders, for following the rocket during the descent, will be preferable to telescopes.

During this period a number of flights were made for the purpose of testing the regulation of the nitrogen gas pressure. A beginning on the problem of automatically stabilized vertical flight was also made, and the first flight with gyroscopically controlled vanes was obtained on April 19, 1932, with the same model that employed the first liquid nitrogen tank. The method of

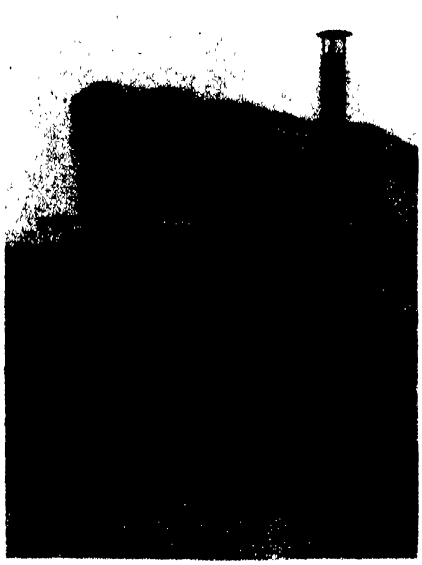


Figure 11: **Control keys being operated at shelter. Note sand bags**

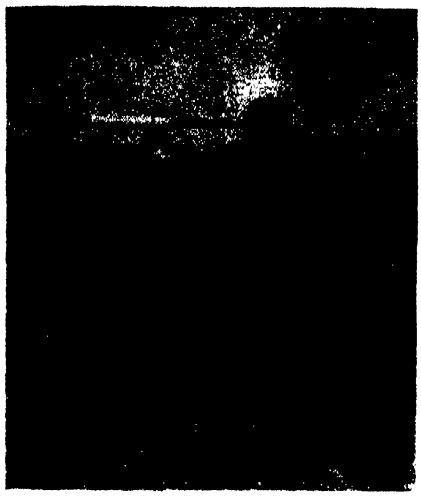


Figure 12: **Observer and recording telescope 3000 feet from the tower**

stabilization consisted in forcing vanes into the blast of the rocket[5] by means of gas pressure, this pressure being controlled by a small gyroscope.

As has been found by later tests, the vanes used in the flight of April 19, 1932, were too small to produce sufficiently rapid correction. Nevertheless, the two vanes which, by entering the rocket blast, should have moved the rocket back to the vertical position were found to be warmer than the others after the rocket landed.

This part of the development work, being for the purpose of obtaining satisfactory and reproducible performance of the rocket in the air, was conducted without any special attempt to secure great lightness, and therefore great altitudes.

IN May 1932 the results that had been obtained were placed before the advisory committee, which voted to recommend the two additional years of the development. Owing to the economic conditions then existing, however, it was found impossible to continue the flights in New Mexico.

A grant from the Smithsonian Institution enabled the writer, who resumed full-time teaching in Clark University in the fall of 1932, to carry out tests that did not require flights, in the physics laboratories of the University during 1932-33, and a grant was received from the Daniel and Florence Guggenheim Foundation which made possible a more extended program of the same nature in 1933-34.

A grant made by the Daniel and Florence Guggenheim Foundation in August 1934, together with leave of absence for the writer granted by the Trustees of Clark University, made it possible to continue the development on a scale permitting actual flights to be made. This was very desirable, as

[5] U. S. Patent, Mechanism for Directing Flight, No. 1,879,187, September 27, 1932.

Figure 13: **The recording telescope and the automatic clock mechanism**

further laboratory work could not be carried out effectively without flights in which to test performance under practical conditions.

Work was begun in September 1934, the shop being put in running order and the equipment at the tower for the flights being replaced. The system of remote control previously used was further improved and simplified, and a concrete dugout (Figure 14) was constructed 50 feet from the launching tower in order to make it possible for an observer to watch the launching of the rocket at close range. The relative positions of launching tower, dugout, shelter, and telescope are shown in Figure 15.

It was of the first importance to perfect the means of keeping the rockets in a vertical course automatically, work on which was begun in the preceding series of flights, since a rocket cannot rise vertically to a very great height without a correction being made when it deviates from the vertical course. Such correction is especially important at the time the rocket starts to rise, for a rocket of very great range must be loaded with a maximum amount of propellant and consequently must start with as small an acceleration as possible. At these small initial velocities fixed air vanes, especially those of large size, are worse than useless, as they increase the deviations due to the wind. It should be remarked that fixed air vanes should preferably be small, or dispensed with entirely, if automatic stabilization is employed, to minimize air resistance.

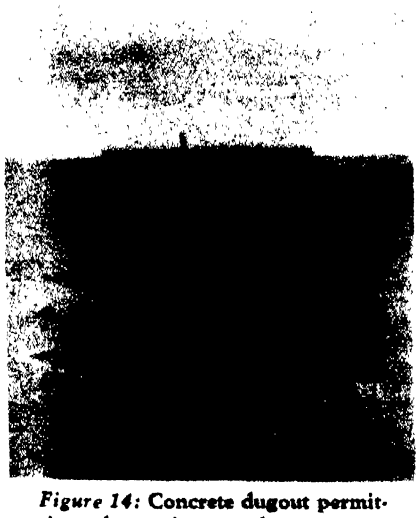


Figure 14: **Concrete dugout permitting observation at close range**

In order to make the construction of the rockets as rapid as possible, combustion chambers were used of the same size as those in the work of 1930-32, together with the simplest means of supplying pressure, namely, the use of a tank of compressed nitrogen gas on the rocket. The rockets were, at the same time, made as nearly streamline as possible without resorting to special means for forming the jacket or casing.

A pendulum stabilizer was used in the first of the new series of flights to test the directing vanes, for the reason that such a stabilizer could be more easily constructed and repaired than a gyroscope stabilizer, and would require very little adjustment. A pendulum stabilizer could correct the flight for the first few hundred feet, where the acceleration is small, but it would not be satisfactory where the acceleration is large, since the axis of the pendulum extends in a direction which is the resultant of the acceleration of the rocket and the acceleration of gravity, and is therefore inclined from the vertical as soon as the rocket ceases to move in a vertical direction. The pendulum stabilizer, as was expected, gave an indication of operating the vanes for the first few hundred feet, but not thereafter. The rocket rose about 1000 feet, continued in a horizontal direction for a time, and finally landed 11,000 feet from the tower, traveling at a velocity of over 700 miles per hour near the end of the period of propulsion, as observed with the recording telescope.

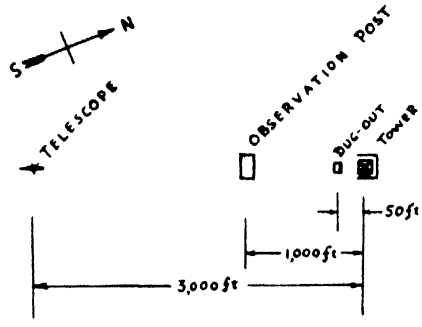


Figure 15: **Showing the relative positions of the several objects named**

Inasmuch as control by a small gyroscope is the best as well as the lightest means of operating the directing vanes, the action of the gyroscope being independent of the direction and acceleration of the rocket, a gyroscope having the necessary characteristics was developed, after numerous tests.

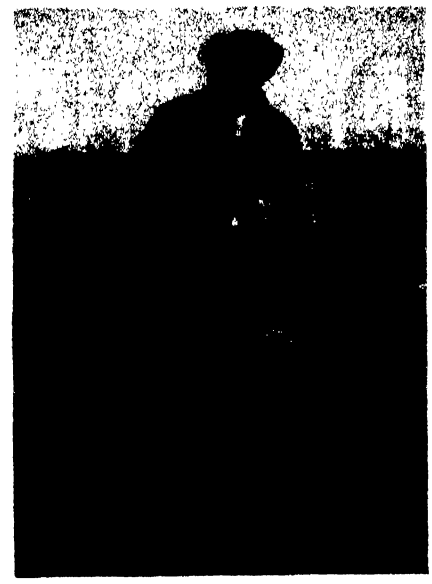


Figure 16: **The author holding in his hands the gyroscopic stabilizer**

The gyroscope, shown in Figure 16, was set to apply controlling force when the axis of the rocket deviated 10 degrees or more from the vertical. In the first flight of the present series of tests with gyroscopic control, on March 28, 1935, the rocket as viewed from the 1000-foot shelter traveled first to the left and then to the right, thereafter describing a smooth and rather flat trajectory. This result was encouraging, as it indicated the presence of an actual stabilizing force of sufficient magnitude to turn the rocket back to a vertical course. The greatest height in this flight was 4800 feet, the horizontal distance 13,000 feet, and the maximum speed 550 miles per hour.

IN subsequent flights, with adjustments and improvements in the stabilizing arrangements, the rockets have been stabilized up to the time propul-

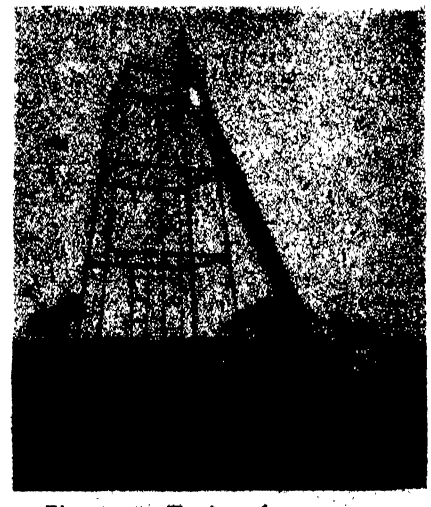


Figure 17: **Testing the gyroscope and directing vanes before flight**

sion ceased, the trajectory being a smooth curve beyond this point. In the rockets so far used, the vanes have moved only during the period of propulsion, but with a continuation of the supply of compressed gas the vanes could evidently act against the slipstream of air as long as the rocket was in motion in air of appreciable density. The oscillations each side of the vertical varied from 10 degrees to 30 degrees and occupied from 1 to 2 seconds. Inasmuch as the rockets started slowly, the first few hundred feet of the flight reminded one of a fish swimming in a vertical direction. The gyroscope and directing vanes were tested carefully before each flight, by inclining and rotating the rocket while it was suspended from the 20-foot tower (Figure 17). The rocket is shown in the launching tower, ready for a flight, in the close-up (Figure 18), and also in Figure 19 which shows the entire tower.

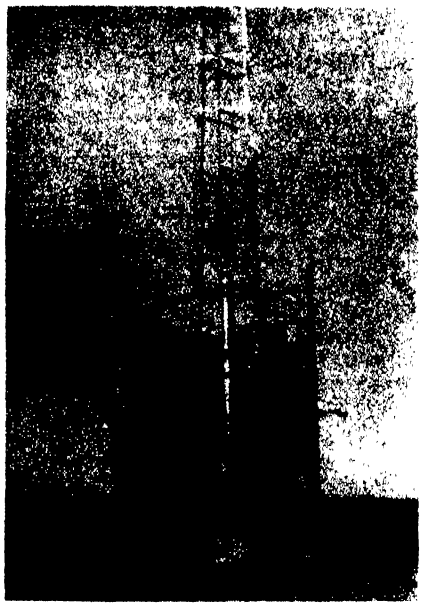


Figure 18: **Close-up of the rocket in launching tower, ready for a flight**

The behavior of the rocket in stabilized flight is shown in Figures 20 and 21, which are reproduced from 16-mm motion picture films of the flights. The time intervals are 1.0 second for the first 5 seconds, and 0.5 second thereafter.

The continually increasing speed of the rockets, with the accompanying steady roar, makes the flights very impressive.

Figure 20 shows the flight of October 14, 1935, in which the rocket rose 4000 feet, and Figure 21 shows the flight of May 31, 1935, in which the rocket rose 7500 feet. The oscillations from side to side, above mentioned, are evident in the two sets of photographs. These photographs also show the slow rise of the rocket from the launching tower, but do not show the very great increase in speed that takes place a few seconds after leaving the tower, for the reason that the motion picture camera followed the rockets in flight.

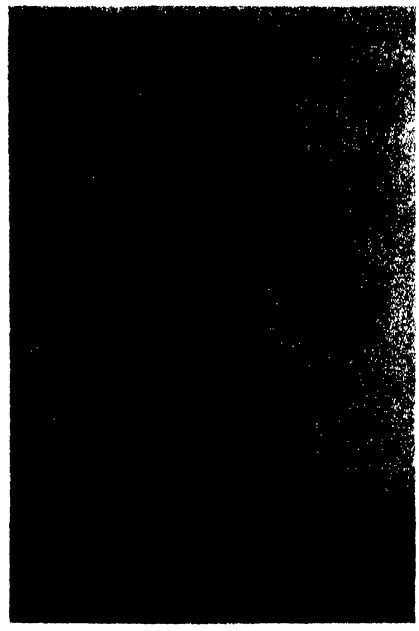


Figure 19: **The same as Figure 18, except that entire tower is shown**

A lengthwise quadrant of the rocket casing was painted red in order to show to what extent rotation about the long axis occurred in flight. Such rotation as was observed was always slow, being at the rate of 20 to 60 seconds for one rotation.

As in the flights of 1930-32 to study rocket performance in the air, no attempt was made in the flights of 1934-35 to reduce the weight of the rockets, which varied from 58 to 85 pounds. A reduction of weight would be useless before a vertical course of the rocket could be maintained automatically. The speed of 700 miles per hour, although high, was not as much as could be obtained by a light rocket, and the heights, also, were much less than could be obtained by a light rocket of the same power.

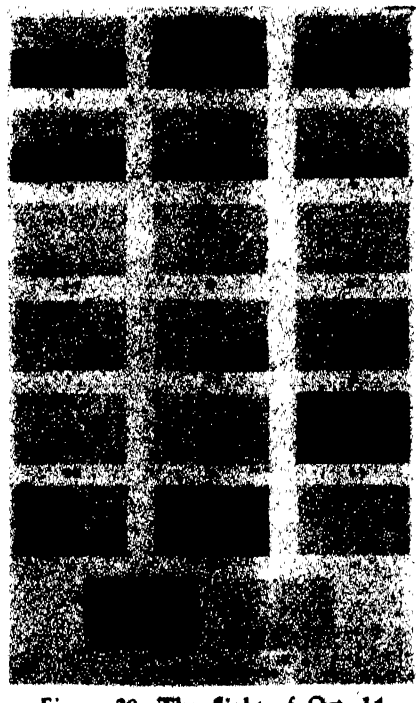


Figure 20: **The flight of Oct. 14, 1935. The rocket rose 4000 feet**

It is worth mentioning that inasmuch as the delicate directional apparatus functioned while the rockets were in flight, it should be possible to carry recording instruments on the rocket without damage or changes in adjustment.

The next step in the development of the liquid-propellant rocket is the reduction of weight to a minimum.

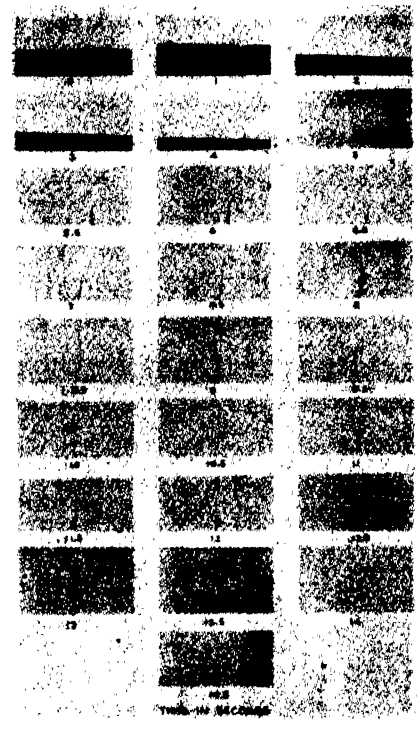


Figure 21: **The flight of May 31, 1935. The rocket rose 7500 feet**

The chief accomplishments to date are the development of a combustion chamber, or rocket motor, that is extremely light and powerful and can be used repeatedly, and of a means of stabilization that operates automatically while the rocket is in flight.

I wish to express my deep appreciation for the grants from Daniel Guggenheim, the Daniel and Florence Guggenheim Foundation, and the Carnegie Institution of Washington, which have made this work possible, and to President Atwood and the Trustees of Clark University for leave of absence. I wish also to express my indebtedness to Dr. John C. Merriam and the members of the advisory committee, especially to Col. Charles A. Lindbergh for his active interest in the work and to Dr. Charles G. Abbot, Secretary of the Smithsonian Institution, for his help in the early stages of the development and his continued interest.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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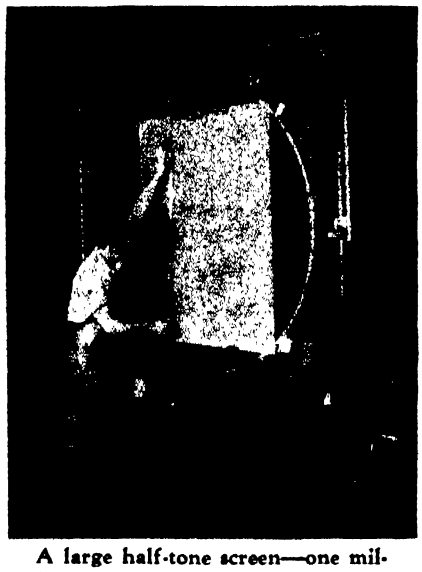
D. H. KILLEFFER
Chemical Engineer

One Million Inches of Fine Ruling on Glass

THE circular halftone screen shown in one of our illustrations is 58 inches in diameter. This screen and two others of the same size are the largest of their kind in existence, and all were made by Max Levy & Company. The screen is shown in place on the plate end of one of the largest color process cameras ever made, in the Chelsea plant of The Forbes Lithograph Company, Boston. It is what is known as a 120-line screen, and is used in making photographic halftone negatives for large lithographic reproductions.



A large half-tone screen—one million inches of fine ruling on glass

The halftone screen is used to produce the dots of various sizes and shapes that can be seen in almost any one-color or multi-color printed reproduction by viewing the reproduction through a magnifying glass. One was used to make the illustrations in this magazine.

In making this huge screen two separate sheets of glass were ruled with parallel lines. These two sheets of ruled glass were then sealed together so that the lines of one sheet were at right angles to the lines of the other. There are over 1,000,000 inches of ruling on these two sheets of glass, and the width of the ruled lines, as well as the distance between them is accurate to 1/40,000 of an inch.

In view of the fact that the halftone reproductions made through this screen contain 14,400 dots to the square inch, and that, in multi-color work, these dots in the various colors have to be located on the printed sheets very accurately to produce the fine clean graduations of color so essential to high grade lithography, it naturally follows that all other equipment—photo-composing, lithographing, and so on—must be accurate and up-to-date in order to match the extreme accuracy of modern photographic equipment.

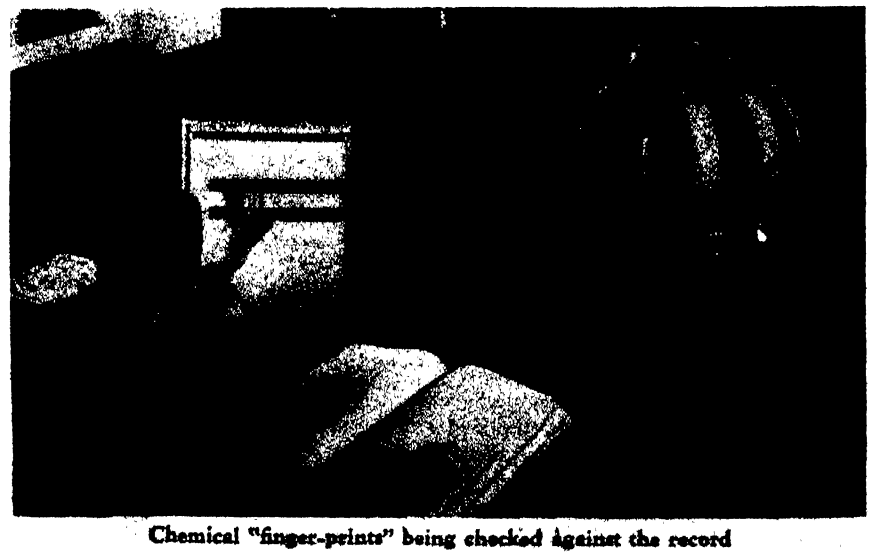
Chemical "Finger-prints"

A UNIQUE method of "finger-printing" chemical substances through the use of X-ray diffraction patterns has been worked out by The Dow Chemical Company.

According to Willard H. Dow, president of the company, the method permits immediate identification of unknowns even though the unknown is a mixture of substances of similar chemical nature. It also permits accurate analysis of particles no larger than the point of a pin. The new method, however, is not applicable to liquids nor to other non-crystalline substances. The company already has acquired a library of 4000 films.

"The taking of X-ray diffraction patterns for the purpose of analysis is not new," said Mr. Dow, "but they formerly proved of little value because they could not be classified. Our chemists have solved the classification problem by taking a leaf from the familiar police system of fingerprinting.

"The molecules of any given compound are arranged in a definite geometrical structure, which is a characteristic of this compound only. Equally characteristic of the given compound is the photographic pattern which results from the interaction of X-rays with this definite geometrical structure. This photographic pattern can be viewed as the 'fingerprint' of the chemical compound. The pattern consists of a sequence of lines of definite positions and intensity. It is these lines which give the key to accurate classification. Just as the lines and whorls of fingerprints permit classification into definite groups with unerring accuracy, so do the positions and intensities of these X-ray diffraction lines.



Chemical "finger-prints" being checked against the record

"We measure the distance from the left edge of the film to A, the heaviest line; to B, the second heaviest line, and to C, the third heaviest. This immediately permits the location of the unknown pattern in the standard classification catalogue. Further examination of the weaker lines quickly gives the final analysis. The system is proving of immense value in experimental work because of its speed and accuracy."

U-V LIGHT AND MOLD

GROWTH of mold on food products, meat, bread and pastry, is prevented by exposing the material to ultra-violet light from special lamps for a period ranging up to several hours.

SMALLPOX MENACE

AMERICANS like to point with pride to achievements resulting from their readiness to make prompt practical application of scientific research. The smallpox situation in the United States provides a distinct blow to any such feeling of pride. Science provided a way to prevent this disease by vaccination against it—as early as the 18th Century. Yet in 1935 there were over 8000 cases of smallpox in the United States.

Instead of decreasing, this preventable disease has been increasing again in the United States, figures collected by the Metropolitan Life Insurance Company show. Half again as many cases were reported last year as in the year 1934.

The black spots on the smallpox map are in the northwestern part of the country. Seven eastern states—Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Pennsylvania, and Rhode Island—had no cases during 1935. In the same year, however, eight Western states—Washington, Idaho, Montana, Wyoming, Colorado, South Dakota, Nebraska, and Kansas—had over 5000 cases.—*Science Service.*

"LEAPING LENA"

ONE man operates a new half-ton tamper driven by the explosions from a gasoline engine. This new tamper not only compacts the soil but moves forward as well as upward in its leap. It has been facetiously dubbed "Leaping Lena" though "Powerful Katinka" might do admirably.

Essentially the device is a four-cycle, single-cylinder combustion engine with very simple mechanical features designed to lift the device bodily by utilizing the energy generated in the explosions. It can be operated so that there will be about 50 explosions per minute and can deliver blows at this rate to the surface to be compacted. The truncated cone body of the machine carries a gasoline tank, and has attached two handlebars through which the operator controls and guides it. Dry cells, ignition coils, and other electrical apparatus are carried in a knapsack-like outfit on the operator's back. The explosions are not automatic but are produced separately by a push button contact on the right handlebar. The average height of a jump is about nine inches and the forward movement at each jump about the same.

"Leaping Lena" at rest

This tamper is a product of the Delmag Company of Germany. It is now being used in the work on San Gabriel Dam No. 1 under construction by the Los Angeles County Flood Control District, according to Paul Baumann, Junior Assistant Chief Engineer.

The designer of this unique tamper undoubtedly had a sense of humor, for in arranging the exhaust ports and the air intake, he created an arrangement to give the appearance of a freakish face which has added much to the amusement of observers, particularly in the dark. With the exhaust ports, or eyes, spitting fire, and the air intake, or mouth, opening and closing with each jump, "Leaping Lena" looks like a mean monster to anyone who first becomes acquainted with it.

"Leaping Lena" leaps

RUBBER FOR ROADS

RUBBER roads are being tried out in Queensland, Australia. The raw material is being sent from Papua (New Guinea). So far they have proved too costly, but more latex is now being used with the rubber with better and more economical results. If they are completely successful, the use of rubber will be extended considerably.—*Australian Press Bureau.*

POLARIZING GOGGLES

LIGHT from practically all scenes commonly viewed contains a large proportion of polarized light. Through the use of the new polarizing plate, developed by Alvin M. Marks, research engineer, it is possible for the polarized surface light to be prevented from reaching the eye, whereas the light carrying the underlying detail is not polarized and is readily transmitted to the eye. In other words, the glare reflected from surfaces viewed is eliminated.

These polarizing glasses are available mounted in spectacle frames. They may be obtained either as plano or flat lenses for normal eyes; or through local opticians who will grind the surfaces of the polarizing plate into any lens prescription required.

In reading, especially when the light is ahead, polarized eyeglasses are desirable. Without them, particularly when the print is on glossy paper, indistinct images of the light tend to cause glare and to obscure the contrast between the print and the paper. When polarizing eyeglasses are worn in reading these highlights are eliminated. The blacks seem blacker and the whites whiter, making print and illustrations more legible.

Now that gem-stone cutting has become a hobby for the amateur, motor-driven machines for the work have been designed and built. See Current Bulletin Briefs, page 180

TIRES

A THIN solution of glycerine applied to worn tires will make them shiny and they will have a newer appearance.

WHIRLPOOLS AND VORTICES

AT the Royal Institution in London, Prof. E. N. da C. Andraded recently discussed "Whirlpools and Vortices." The best example of what is ordinarily thought of as a vortex is the whirlpool that is formed where the water runs out of a bathtub or basin. There is a widespread belief that this always spins one way, clockwise or counter-clockwise, and that this is due to the rotation of the earth. Actually, however, if the water is allowed to come to complete rest in a vessel where the hole is accurately in the middle, and if the plug is carefully withdrawn, no whirlpool is formed. The whirlpool that is generally observed is due to some slight rotation given to the water near the edge of the vessel, which, by the laws of fluid motion, becomes very much accentuated where the water runs out. The direction of the spin depends on the direction of this slight motion. If the spin is actually always in the same direction in a particular bath, it is because of some chance influence, such as the position of the taps.

The spin of the earth should actually give rise to a rotation of the water where it runs out, but the effect is far too small to be observed with a bath or basin. Where a large, still, sheet of water runs out through a vertical pipe, as at the intake of a water

turbine, the effect should, however, be large enough to observe. It is, in fact, found that under these conditions whirlpools form, and that the spin of the water is in an opposite direction in the northern and in the southern hemisphere, as it should be.—*Nature* (London).

OIL BURNERS

SHIPMENTS of oil-burning equipment for domestic and commercial use during 1935 increased 38 percent over 1934 shipments, the total number of units moving from manufacturing plants being 138,899, according to the U. S. Bureau of the Census.

Air Conditioning the Airliner

AIR conditioning the transport plane in summer means pre-cooling the interior air before take-off. Once the airplane is at high altitude a natural system of ventilation keeps the passengers comfortably

Pre-cooling the interior of an airliner before it leaves the ground

cool; it is at the airport that artificial cooling must be used.

The conditioner shown in one of our illustrations is eight feet long and is mounted on a standard automobile chassis. It delivers 1200 cubic feet of filtered, cooled, dehumidified air per minute and can reduce cabin temperature from 100 degrees, Fahrenheit, to 39 degrees. The cooling medium is calcium chloride brine, and the pre-cooled air is introduced into the cabin through an insulated metal hose. The weight empty of the conditioner is 2700 pounds; when filled with refrigerant it weighs 5200 pounds.

In winter the process will be reversed, with steam or electric coils warming the air until the engine exhaust-gas heating system takes charge of temperature control.—*A. K.*

Refrigeration on Pacific Airways

THE *Clippers* operated by Pan-American in the Pacific are supported by a stupendous ground organization. A recent issue of *Refrigeration Engineering* gives additional emphasis to the effort exerted. On the tiny islands, Midway, Wake, and Guam—claimed by the United States in 1898 but regarded as unimportant until recently—the landing base is fully equipped with hospital, radio, machine shops, kitchens, and the like. Quite recently 50-room, knock-down hotels were shipped to each of these specks of American territory. To combat the tropical temperature refrigerators have also been provided. These are in the form of huge boxes, constructed of wood with waterproof insulation, and a sheathing of eight layers of aluminum foil in crumpled form, four inches thick altogether. Compressors, methyl chloride in finned coils, all the elements of a modern refrigerating plant are there. Three compartments are available for meat, fish, and fruits and vegetables. The operators of Pan-American are pioneers in true American tradition but they have many more technological resources to back them up than those available to the hardy men in covered wagons.—*A. K.*

New Aviation Fuel

ONE of the main reasons why aircraft engines have increased in specific power and in fuel economy is increased compression ratio. But increased compression ratio and higher powers for a given piston displacement are only possible with fuels of higher "octane rating." Volumes have been written on "octane rating." In the simplest terms we may say that high octane rating means "no-knock" at high compression ratios. High octane ratings have been achieved hitherto by adding tetraethyl lead to gasoline, and blending "iso-octane" with that substance. But iso-octane is very expensive and only available in small quantities.

The Standard Oil Development Company now announces, in a paper read before the Society of Automotive Engineers by H. E. Buc and Major E. E. Aldrin, a new fuel which will give the much desired 100 octane rating, but at a much lower cost than previously. It is available in unlimited quantities.

This new fuel is termed EL-435. In it, tetraethyl lead in the ratio of three cubic centimeters per gallon of gasoline is still included, but the gasoline is blended with isopropyl ether. This compound is derived from propylene, and there is enough of the raw material being produced in the United States to give us 850,000,000 gallons a year of the finished fuel—more than ten times the annual consumption of aircraft gasoline.

Why isopropyl ether has these remarkable properties is a highly technical question, involving chemistry, thermodynamics, combustion technology, which space will not permit us to deal with.

But it is possible to get a conclusive idea of what the new fuel will mean to the aviation industry.

As compared with ordinary aviation gasoline there should be a saving of 15 percent in fuel consumption, with a corresponding increase in possible pay load. Or, alternatively, it will be possible to increase the power some 30 percent without the present prohibitive costs. Hitherto only the Army and Navy Air Services have been rich enough to utilize 100 octane gas. Commercial operators have resorted to the use of 100 octane fuel at take-off or in emergencies, switching over to ordinary gas for steady flying. Now they will dispense with "switching" and be able to use the high octane rating gas in normal flying.

The importance of this new fuel in air transport economics, in long flights, as across the ocean, can hardly be overestimated.—*A. K.*

The Fairey Bomber

THE new Fairey Battle, a light two-seater bomber, has created quite a sensation in Europe. While great secrecy is observed as to its performance figures, the English press proudly states that it is at least 100 miles per hour faster than any French bomber, and that its speed is over 250 miles per hour; gossip has it that the top speed is close to 300 miles per hour, coupled with adequate range and high bombing capacity. The span of the machine is over 54 feet, and the overall length is 42 feet. Yet in spite of its size and powerful fighting equipment, the Battle is reported to have carried out perfect loops, rolls, half-rolls, figures of eight, and so on, with the ease of a single seater pursuit. Thus the British apparently have the combination of a bomber with the maneuvering qualities of a fighter.

This combination of qualities is due to very clean aerodynamic lines, careful control design, retractible chassis, large aspect ratio, and so on, in which practices the British have undoubtedly followed American leadership. Where the British have

Courtesy of *Flight*

The Fairey Battle in flight, with wheels retracted

Courtesy of *Flight*

A side view of the Fairey Battle, showing its clean lines

the "jump" on American constructors is in the engine. This is a liquid-cooled 12-cylinder engine of great power yet very small frontal area. Rumor says that we have a similar engine in the United States, but the British have actually put such an engine into use—so they are a step ahead in this respect.

Take-off and landing with the Battle are helped by the now conventional flaps fitted in the trailing edge of the wing. An automatic pilot is installed for long flights and under conditions of zero visibility. The cockpit is exceptionally roomy, with comfortable seats for pilot and observer, and is totally enclosed by a tunnel-shaped top, made of tough transparent material, which can be opened partly or wholly as the circumstances of aerial combat or bombing attack may demand. The bomb load is carried in special compartments within the structure of the airplane and does not, therefore, detract from the performance.

Now and again we hear of pilots bringing ships down with the landing gear still retracted. In the Fairey Battle careful precautions have been taken against forgetfulness of this sort. As the pilot throttles back the engine, the word "wheels" appears in lights on the dashboard, and an electric horn is sounded. As soon as the pilot releases the undercarriage the horn ceases to blow and the word "wheels" is replaced by a red light which turns to green when the chassis is locked ready for landing. After take-off another red light appears to warn the pilot if the wheels are not fully locked in the "up" position.

Our curiosity is greatly aroused by the hints given as to structure. For example, the fuselage is constructed of long duralumin strips. While the Aluminum Company of America has been successfully experimenting with the welding of high strength aluminum alloys, the process has not yet been fully accepted by the aircraft industry. Therefore it is interesting to read in English descriptions that ". . . these flaps were an excellent example of welding. The stiffeners and outside skin are all fastened together in this way."—*A. K.*

Europe Arms in the Air

THE Aircraft Year Book for 1936, published by the Aeronautical Chamber of Commerce, is as good as ever and covers completely every sphere of aviation activity, manufacture, development, transport, and so on. But in so far as the American scene is concerned, our readers are perhaps already familiar with a good deal of its contents—though it is an invaluable and comprehensive book of reference. What we found most interesting and, in view of the European situation, highly ominous, was Chapter 3, entitled "Other World Air Powers." Here is the table of Combat Airplane Strength, projected into the future, which speaks for itself:

	Jan. 1935	Jan. 1936	Jan. 1937
British Empire	2800	3600	4500
France	3600	3400	4000
Russia	3000	3400	4000
Italy	2300	3300	4000
United States	2060	2800	3000
Japan	1850	1800	2100
Germany	600	1600	2600

Let us quote from this chapter: "The United States, France, and Japan lost in actual numerical strength during 1935."

Here is something else, which is both gratifying and yet a warning signal: "Great Britain, France, Italy, and Germany have spared no expense in perfecting their government laboratories for aeronautical research and experimentation. For years they have watched the work of the National Advisory Committee for Aeronautics in the United States. They know that the superior performance of American commercial and military airplanes must be attributed partly to the knowledge gained from the research in the NACA laboratories at Langley Field. The foreigners are now establishing laboratories in an effort to overcome this American leadership in technical development." We must take note of this.

Russia is frequently held up to us as an example of everything as it should be. Let us quote: "Russia's large fleet can be compared to those of other nations only in numbers. With few exceptions the Russian planes are slower, more cumbersome, and more difficult to keep in repair. That can be attributed to several factors, among them unskilled personnel in the shops, the relatively few capable designers, and the system of state-owned and operated plants."

Great Britain is feverishly working on an expansion program. France is making real efforts. Goering's plan in Germany is for 2600 combat planes by the end of 1936. In Germany the largest production plant is that of Junkers at Dessau. It employs 15,000 men and its capacity production, if devoted to one model, is 1000 completed combat machines a month. "When one realizes that the entire industry in the United States, Great Britain, or France could produce that number of planes only after expanding for seven months under actual wartime mobilization conditions, the significance of the German program becomes apparent."

The moral of this splendidly written chapter is clear. In the air we shall not long hold our technical superiority and we certainly do not have a numerical superiority. Naval treaties and limitations of naval vessels are all very well, but the aircraft program and progress of the United States must be carefully considered by the most pacifistic of our citizens.—*A. K.*

LIGHTNING

ONLY three persons in every million of our population were struck down annually by lightning in the last 10 years. Outdoor workers are in much greater danger than city dwellers, so certain agricultural states have a higher lightning mortality.

Airliner Housekeeping

THE recent redecoration of the entire fleet of planes of United Air Lines was accomplished with the aid of an interior decorator who supplied striking colors and materials. Like a good housekeeper, the transport company wishes to keep all this in the best possible condition. Hence our photograph of an airplane mechanic hard at work going over the upholstery, rugs, and

"Housecleaning" the airliner

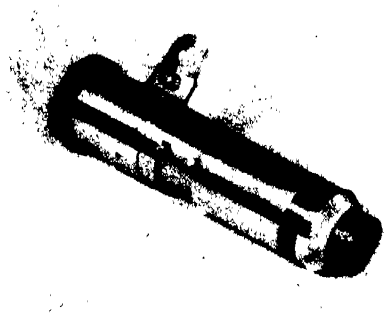
so on, with a powerful portable vacuum cleaner. This may lessen the glamour of being an airplane mechanic for some of our youngsters!—*A. K.*

Instrument Illuminator

EVERY minor improvement in aircraft accessories helps the flying game, and the new Fairchild Instrument Illuminator will be a boon to many a pilot who has to fly in darkness and follow the lights, and yet must be able to consult instruments and

maps. The illuminator shown in the photograph is only 3¾ inches long and has a diameter of ⅞ of an inch. The current is only ¼ of an ampere at 12 volts.

The illuminator comprises a metal shell fitted at its forward end with a knurled ring to adjust a diaphragm through which the light is projected. The light bulb is



Aircraft instrument illuminator that uses a special optical system

mounted on a socket fitting into the rear end of the shell and is instantly removable.

In the side of the shell is a sliding shutter which may be opened to light the cabin for reading maps or general illumination. Between the bulb and the diaphragm is a light-collecting lens; another lens at the forward end confines the beam to a definite area.

With this optical system, the shape of the beam on the instrument panel is fully controlled. The beam may be confined to a few instruments or to a special group by the insertion of a mask at the projecting lens.

The most effective location for the device is above the head of the pilot on the center line of the airplane with the forward end aimed at the instrument panel. When the illuminator is thus located the usual reflection from the instrument panel is reflected downwards and therefore away from the pilot's eyes.—*A. K.*

CORN—SOLVENTS

IN applying nitrocellulose lacquer to the average automobile, the solvents consumed are equivalent to the quantity that can be made from nearly two bushels of corn, according to Charles L. Gabriel of Commercial Solvents Corporation.

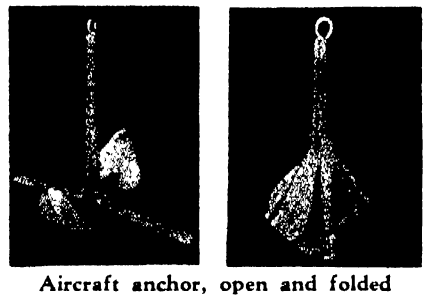
Aircraft Anchor

LANDLUBBERS know that anchors are used to moor ships at sea, but very little else—at least the landlubber writing this note pleads such ignorance. Yet centuries of experience have gone into the development of the anchor, and there is a good deal more to it than just "plain anchor."

The mooring line is fastened to an eye at the top of the "shank." The length of the line should be at least four and preferably six times the depth of the anchorage to provide maximum holding power. At the bottom of the shank are arms which carry the curved "flukes" with which we are all familiar, however rarely we may go to sea.

The holding power of the conventional anchor as used by the Navy is only 12 or at most 15 times the weight of the anchor. Hence the huge weight and size of Navy anchors.

In sea-going vessels, the weight of the anchor is of little importance. In flying boats, however, weight reduction is a vital element. It was therefore quite natural that John K. Northrop, the noted aircraft designer, should turn his attention to the design of an anchor which, for a given weight, should have maximum holding power. As a result, the Northill anchor was developed by Mr. Northrop in conjunction with Pan American and other seaplane operators. In one of the two accompanying photographs the anchor is shown ready for use. Its first distinctive feature is the novel "fluke" which was developed after innumerable "digging in" tests. This fluke with its pointed tip has enormous penetrating power and consequently great holding power. At the same time, the fluke is so shaped that if a pull is exerted directly upwards on the eye, the fluke immediately cuts its way out from the bottom of the sea. The "stock" or cross member rests on the bottom of the water when the fluke is embedded and also adds to the drag or holding power. The Northill anchor is stated to have a holding ratio of 60 to 1 as compared with the 15 mentioned above for conventional designs. The anchor is generally made of stainless steel, which is somewhat more expensive



Aircraft anchor, open and folded

than galvanized iron but also less troublesome from a corrosion point of view.

On the Sikorsky *S-38* amphibians, the old 65-pound anchor has now been replaced by a 12-pound Northill. Since space also is at a premium in aircraft work, the fluke and stock arms can be folded or hinged together as shown.—*A. K.*

Ihrigizing

BY the use of its inventor's name, this process title succeeds in hiding its essential nature. To the chemist or engineer, however, the much more prosaic explanation will suffice that silicon is the key to the situation. For "Ihrigizing" is a method of driving silicon into steels or ferrous articles to form a protective case of almost any desired thickness. This case is, in technical parlance, "ferro-silicon," or approximately 14 percent of silicon itself.

Ihrigized parts are rendered somewhat surface-brittle, says the *Industrial Bulletin* of Arthur D. Little, Inc., so that they must be ground to shape instead of being machined. Bolts and nuts, chemical and machine parts are cased after the thread-cutting operation has been done. The treatment is said to increase the size of the original article by not more than one to three thousandths of an inch, and may actually decrease the weight slightly with no distortion.

In resistance to chemical attack by hot concentrated acids, such as muriatic and sulfuric, Ihrigized steels display remarkable properties, enduring for months where the base metal alone would last only a few days. Wet chlorine and salt spray are also successfully withstood. These chemicals, though less publicized than acids, do more damage in aggregate dollars and cents. The resistance to heat and wear is also greater than that of many types of treated steel, and may lead to wider adoption for special uses. Unusual electrical and thermal properties are shown by wires made of Ihrigized steel. Sheets to be processed, however, must not be too thin, as the active element, silicon, penetrates rapidly, and may produce a case that extends all the way through the material. One positive requirement for Ihrigizing is that the sulfur content of the base metal be low.

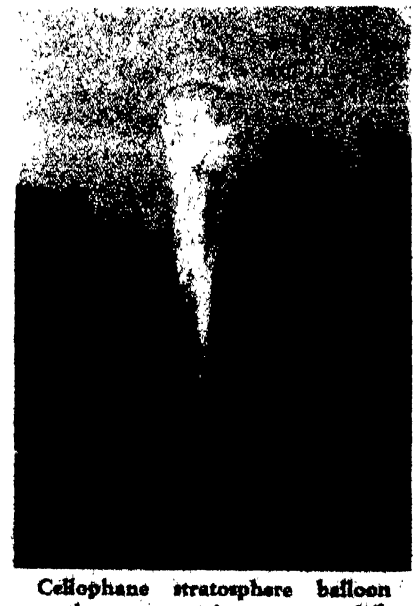
At present small machine parts are being commercially treated, with important work under way in Ihrigizing long tubes. As to cost, there is considerable latitude for a process which endows a cheap base metal with acid-resistant qualities of the much more highly-priced stainless steel, or the effectiveness of very high silicon irons.

Balloons for Cosmic Ray Research

WE are indebted to Dr. Thomas H. Johnson of the Bartol Research Foundation of the Franklin Institute for first-hand information on the high altitude balloons recently employed in cosmic ray research.

The balloons are 16 feet in diameter, and are pear shaped, consisting of a sphere surmounting a 30-degree cone. Fully inflated they are 26 feet in height. "Orange peel" sectors are cut from transparent Cellophane, 0.0008 inches thick, and cemented together with Scotch tape. There are 16 such sectors, which are widest at the equator. At the top the sectors are brought together to a point.

Just above the load ring on the inside, the appendix—three feet long by five inches in diameter—broadens out conically and is cemented to the neck of the balloon. Hydrogen is introduced through this appendix, which also acts as a valve, preventing the air from entering but allowing the hydrogen to escape when the balloon is



Cellophane stratosphere balloon ready to carry instruments aloft

fully inflated. The bag has a capacity of 1800 cubic feet, but is inflated on the ground to only 500 cubic feet, giving a gross lift of 28 pounds. The great difference between the inflation at ground level and the inflation at altitude is the key to the altitude possibilities of the balloon. The comparatively low lift of 28 pounds explains why Cellophane and other extremely light elements of construction and equipment are employed. Thus the bag weighs only six pounds and the ballast bag and release mechanism only ½ of a pound. The remaining lift is balanced at the start of a flight with sand. The ballast release mechanism operates by means of a wind cup in such a way as to release sand when the balloon ceases to rise at a predetermined speed of two meters per second.

At the start the balloon is held by a string so that sand is released until the balloon begins to lift the parachute and the radio apparatus, which weighs seven pounds. The balloon is still held by the string until five pounds more of sand have been discharged. At that instant the string is released and the craft rises at the rate of two meters as previously mentioned. Then the rise shuts off the sand valve and there is steady ascent, with automatic ballast and gas control until an altitude of 13 miles is reached.

A constant record of the height of the balloon is transmitted to a radio receiving station on the ground. For this purpose a mercury barometer is used and the height of the mercury column governs the frequency of the transmission of "dots." These dots vary in frequency from one per second at ground level to ten per second at the highest altitudes. Cosmic ray intensities will also be recorded by a system of dots from the radio transmitter. The signals are recorded in the laboratory by converting the dots into deflections of a small mirror attached to an oscillograph. This causes a beam of light to flicker across a slit, making a photographic record on a film.

The advantage of the system from the standpoint of cosmic ray measurements is that it enables the scientists to obtain cosmic ray intensities in sparsely inhabited regions where self-recording equipment sent up in free balloons might not be recovered. Manned balloon ascensions to similar heights present enormous difficulties.—*A. K.*

Improvements in Dry Cleaning

By using new types of solvents which reduce the danger of fire in dry cleaning, this widespread industry is developing into new fields with new economies in keeping our clothes clean. Formerly, when highly flammable naphtha was the solvent used, the constant danger of fire required the isolation of dry cleaning plants away from dwelling and thickly populated areas. The first step toward greater safety was the introduction of non-flammable solvents containing chlorine, carbon tetra-chloride, trichloro-ethylene, perchloro-ethylene, and others produced by chemical synthesis. At about the same time, steps were taken by the National Association of Cleaners and Dyers in co-operation with the Bureau of Standards to develop a less dangerous petroleum naphtha which would be cheaper than the synthetic materials. This research developed the so-called Stoddard Safety Solvent, which is very similar to the petro-

Science proves Philip Morris superiority

Tests conducted by eminent medical authorities showed that in the majority of cases, irritation of the nose and throat due to smoking, cleared completely on changing to Philip Morris. All the others definitely improved.

Philip Morris & Company do not claim that Philip Morris Cigarettes cure irritation. But they do say that an added ingredient, a source of irritation in other cigarettes, is not present in Philip Morris.

Smoke Philip Morris for pleasure. It's not only good judgment . . . it's good taste.

✓ *For complete discussion of cigarette manufacture and its effects on irritant properties of smoke, see "If You Smoke", Scientific American, June, 1936.*

Call for PHILIP MORRIS

America's finest 15¢ Cigarette

leum naphthas formerly used except that it is much less flammable. Still safer petroleum solvents have been developed to fit revised methods of operation.

The result of this movement to make dry cleaning plants safer from fire has been to permit the spread of the industry and the introduction of dry cleaning plants into laundries. An educational program to instruct dry cleaners in better methods of operation has improved the quality of work done at the same time that its cost has been reduced.—*D.H.K.*

Germicidal Rays

A NEW low-wattage gaseous conductor device which produces radiations germicidal to mold spores in the air and known as the Sterilamp is announced by the Westinghouse Lamp Company. Annual food spoilage, which runs into millions of dollars and which is one indirect cause of high food prices, is largely the result of mold spores. Baked goods, treated with these germicidal rays, remain mold-free for long periods and can be completely consumed in the home before they spoil.

Permeating the air of refrigerator storage rooms with these germicidal rays kills mold spores and spoilage bacteria, makes it possible to tenderize, or "age," meat at higher temperatures without danger of spoilage from mold or putrefaction. The process is speedier and promises considerable savings in refrigeration costs and reduced trimming losses.

For years scientists have known that certain radiations outside the spectrum of visible light possessed germicidal characteristics, but they have never been able to devise means of producing them economically and practically. The new germicidal lamp produces these rays efficiently and effectively. It is a slender glass tube containing a small quantity of special gas. Electricity sent through the gas produces the germicidal rays.

Tests indicate that the lamp can also be used to sterilize conditioned air.

"The only trimming necessary when meat is aged under these radiations," says Dr. Robert F. James, "is the removal of a dark surface film. Loss of weight is largely eliminated by maintaining 90 percent or higher humidity which is made possible by use of these devices. In present commercial practices, weight losses amount to about 30 percent from slaughterhouse to table. Using these germicidal rays for artificial aging can reduce this loss to about half.

"So great is the waste on high-hung beef that only diners at high class hotels and restaurants can afford to eat it."

Other advantages in the packing industry are the vast savings in refrigeration costs. Meat can be aged at 10 to 15 degrees higher temperature and in about one third the time, thus reducing the amount of storage space required. The possibility of "tenderizing" meat while in transit from Chicago to New York is not inconceivable in the future, in the opinion of Dr. James.

X-Ray Equipment on the "Queen Mary"

PASSENGERS who require medical attention aboard the new superliner *Queen Mary* are cared for in a modern, completely equipped hospital. The General Electric X-Ray Corporation furnished the X-ray equipment shown in our illustration. The device not only takes radiographs, but may also be used fluoroscopically if the medical officer wishes to examine the patient visually.

Platinum Helps the Farmer

THE average farmer would no doubt be amazed to learn that such an aristocratic metal as platinum is one of his best friends. Such is the case, however, for the cost of fertilizer enters into the cost of the crop, and platinum has reduced the cost of fertilizer.

This is done by the use of platinum as a catalyst for synthetically producing nitric acid, one of the most important fertilizer bases. These catalysts are made of an alloy of platinum and its sister metal rhodium, usually in the form of gauze. Practically all the world's nitric acid is produced with such catalysts, and nations which, like the United States, lack natural deposits of nitrates, no longer fear the possibility of being without this valuable substance.

Toxicity of Rotenone

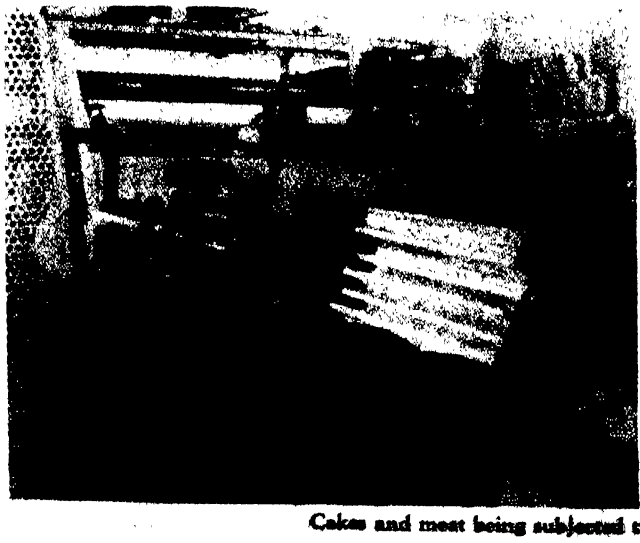
EXTRACTS of derris and cube and of rotenone, the active principal of these roots, have been widely heralded as fatal poisons to insects but quite innocuous to warm-blooded animals. Experience has shown that this desirable characteristic is only partly true—if at all. Recent investigations by scientists at the U. S. Department of Agriculture have shown that laboratory animals can be poisoned by any of the three and that the extracts of the natural products are more toxic to animals than the purified rotenone. The toxicity of these insecticides to animals varies over a wide range depending both on the method of preparation and on the form in which they are administered. Apparently belief that rotenone and substances containing it are non-toxic were based on the very slow absorption of the poisons when administered by mouth. Solutions of any of them in olive oil are definitely toxic.—*D. H. K.*

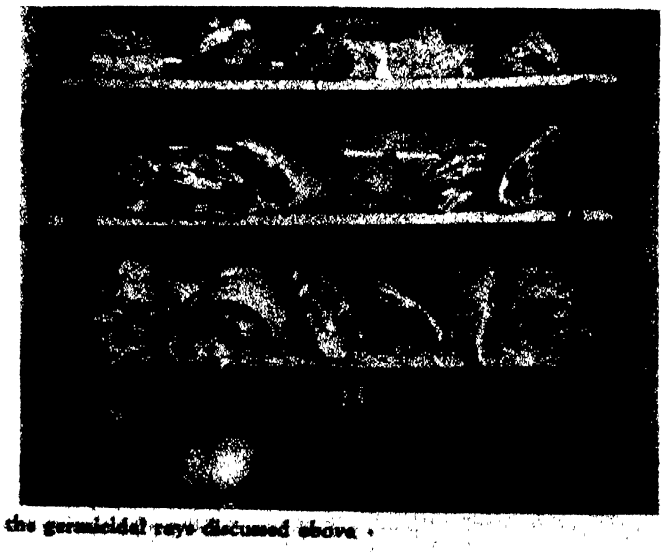
Odd Cheese Curing Rooms

A NEW use for an old coal-mine shaft in Pennsylvania has been found. It makes an excellent curing room for domestic Roquefort cheese, says Dr. L. A. Rogers, of the Bureau of Dairy Industry of the United States Department of Agriculture. The shaft has been whitewashed and partitioned, and dampers have been installed. The air forced through the wet shaft by the mine fan maintains this room at 46 degrees to 48 degrees, Fahrenheit, with humidity near saturation.

There are other Roquefort projects in this country using unusual local facilities. In the damp sandstone bluffs of the Mississippi at St. Paul, caves have been cut and are used as curing rooms for Roquefort cheese made from cow's milk.

For a number of years a mountain farmer on the Pacific coast has been making a good Roquefort from goat's milk. He ripens the cheese in a room literally built in a large spring of very cold water. The water





Cakes and meat being subjected to the germicidal rays discussed above

not only flows under and around the room, but onto the roof so that it pours over the wall and turns a fan to circulate the air inside.

The Department has been interested for a long time in the production of domestic Roquefort cheese from cow's milk. It has established the fact that the special flavor, appearance, and texture of this cheese depend in a large measure on the control of the growth of molds and bacteria, and not on climatic conditions or peculiar herbage in the pastures, or even on the use of sheep's milk or goat's milk exclusively. The Department has carried on most of its Roquefort-cheese experiments with cow's milk.

The process of making Roquefort cheese includes inoculating the curd with a mold grown in loaves of bread. The bread finally becomes a mass of mold in the spore stage. This is dried, ground to a powder, and sprinkled over the curds as they drain.

SOLAR ENERGY

IF all the sunshine in the United States could be converted into usable energy, there would be available 7000 trillion horsepower.

World's Steepest Inclined Railroad

WHAT is believed to be the world's steepest standard-gage railroad is located near Ripple, Oregon. It is 3421 feet in length, starting up on a 28 percent grade, continuing on a 79 percent and cutting down to 50 percent as it nears the top of the incline.

The railroad brings logs from a 300,000,000-foot stand of timber lying on the high mountain ridges and delivers them at the foot of the canyon. The fine stand of Douglas fir and west coast hemlock to be cut is very valuable, covering a great area, so the matter of its removal is an important one, involving as it did the lowering of logs 1500 to 2500 feet down the narrow and precipitous side of the canyon of the Salmonberry River and getting them to the railroad at a convenient point.

Engineers decided that an ordinary railroad was out of the question, according to *Science Service*. Owing to the nature of the country, about 15 miles of mainline would have been required, the cost and construction of which would have been prohibitive. An incline was decided to be the most economical solution and the site was chosen. This lay on the "nose" of a sharp ridge, allowing grading to be cut to a minimum and permitting easy removal of material.

The incline is a double-track counterbalanced one, lowering one loaded car at a time and at the same time bringing up an empty one. Cars used on both straightaway and incline are those ordinarily used in northwest logging, weighing 14 tons when empty. With 28-ton loads of logs, their descending weight is 42 tons. An average car load is 9000 feet of timber and under ordinary hauling conditions about 250,000 feet of timber can be hauled in a day.

The approximate cost of the grade was about 6500 dollars, whereas a standard logging railroad built between the ends of the

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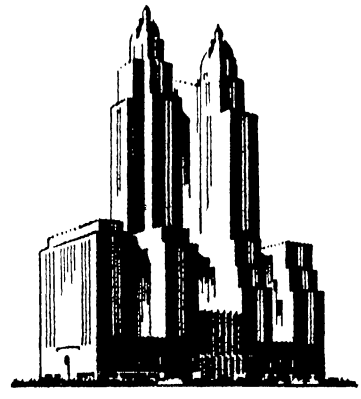

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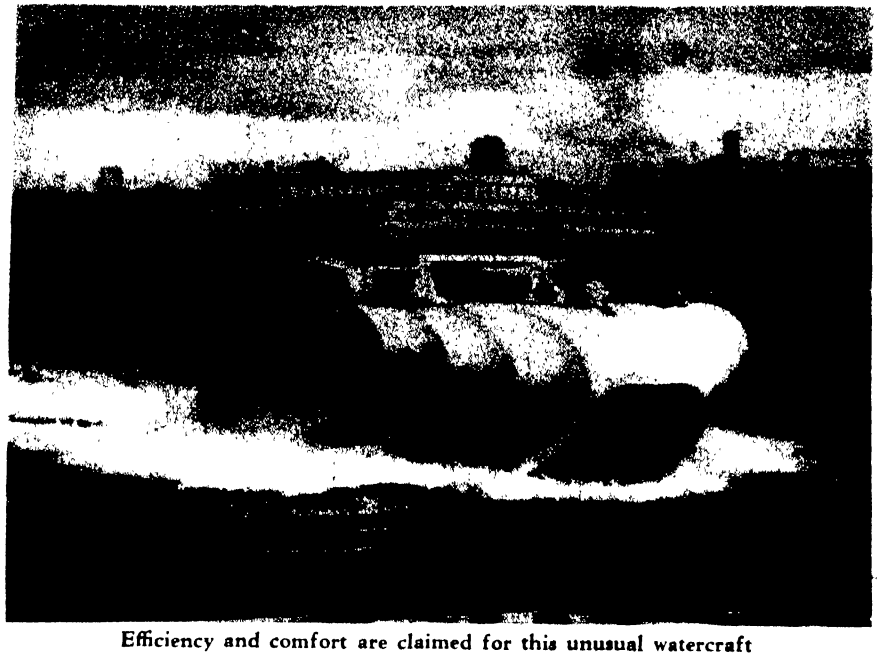

Efficiency and comfort are claimed for this unusual watercraft

incline would necessitate an expense estimated at 25,000 dollars.

"Inclines are not the most desirable method of handling logs," says Mr. Bollons, the designing engineer, "but as the remaining stands of timber are in more or less isolated regions, requiring long and expensive railroads, these inclines are going to come into more general use in the future."

ETHYLENE RIPENING SAFE

ETHYLENE, used to hasten the coloring of fruit and the ripening of walnuts, produces no changes which will not occur naturally in a longer time, according to Chace and Sorber, chemists in the United States Department of Agriculture.

Aerodynamic Watercraft

A NEW and unusual type of watercraft, said to have a hull efficiency more than one third greater than any motor boat of previous design, has been successfully tested by a Portland, Oregon, inventor. Known as the Strode Aerohydrocraft, the boat is unique in that it incorporates for the first time both aerodynamic and hydrodynamic principles in design.

The hull of the craft is similar in construction to the wing of an airplane and has, extending from its sides, a wing-like structure composed of airtight compartments. These wings serve to give "lift" to the boat when it is in operation.

V. W. Strode of Portland is the inventor and holds basic patents on his development. Powered with a stock Ford V-8 engine, experiments with the craft were worked out in co-operation with the marine engineers of the General Petroleum Division of the Socony-Vacuum Oil Company whose marine lubricants and fuel were used in all tests.

The top service speed of the new craft is at present 40 miles per hour, although further development is expected to make for even greater speed. The aerodynamic features are said to give it an unusual riding ease.

Complete and scientific streamlining of the boat serves further to augment its efficiency.

In addition to being more efficient in operation, the hull of the new type craft is non-sinkable and non-capsizeable. Following tests, the boat was taken over by the city of Portland, where it is being used as an ambulance and first-aid boat on the Willamette River.

Stomach Periscope

AN instrument that might be called a stomach periscope may be the means of preventing many cases of stomach cancer. The instrument, a flexible tube called a gastroscope, for looking inside the stomach, was designed by Dr. Rudolph Schindler of Chicago and his colleagues Drs. Marie Ortmayer and John F. Renshaw, states *Science Service*.

The flexibility of the instrument gives it a tremendous advantage over the earlier style of rigid gastroscope. Made of flexible metal, covered with rubber, it contains 46 lenses on the inside. At the end of the two and a half foot tube is a small light. The tube is no larger around than one's finger.

Because of its flexibility it can be bent backward and to the side or in any direction, thus enabling the physician to see every part of the stomach. This was not possible with the old model rigid gastroscope. Dr. Schindler, in showing it to physicians, held a book at one end and turned the tube in all directions, but the person looking through the tube could read the printed page no matter how the tube was bent.

The patient experiences no discomfort and there is no danger of injury with this instrument. The patient's throat is anesthetized, the tube is passed down it, and the examination of the stomach is made in a minute or two. This can be done in the doctor's office and the patient is able afterwards to go on to his work. One patient had the tube passed into his stomach 65 times.

This instrument gives far more accurate information about the condition of the stomach than even the X ray. With it the physician will be able to detect not only the presence of cancer, but the amount of cancer present and whether it is an operable type.

Breaking and Smelling 5,000,000 Eggs a Day!

THE delicate art of egg-smelling—the ability to detect one bad egg among a million good eggs by the sense of smell—has probably been developed to a higher degree of efficiency in Shanghai, China, than anywhere else in the world. This highly specialized job of egg-breaking and egg-smelling furnishes steady employment to hundreds of Chinese girls, as a part of China's vast frozen egg industry—the largest industry in China which uses mechanical refrigeration.

Much of this refrigerating machinery and freezing equipment has been furnished and installed by York, Shipley, Fed. Inc., the Shanghai branch office of the York Ice Machinery Corporation.

Methods of handling, inspecting, freezing, and processing eggs have been developed on an extensive scale with the

Courtesy York Ice Machinery Corporation

These Chinese women break and smell eggs all day long!

introduction of modern refrigeration. Today, there are some half dozen establishments devoted to egg-handling and processing in Shanghai, center of the egg-freezing industry, and each of these large plants requires 1,000,000 or more eggs per day.

Chicken raising on a large scale is unknown in China. In fact, there are practically no commercial chicken farms in China, but this vast production of eggs comes from small individual "farms" where the average number of chickens does not exceed 100. Boats sail down the Yangtze River every day to collect eggs from the various concentration points along the banks, and deliver them finally to the egg-breaking establishments in Shanghai.

One of the largest of these establishments, known as the Henningsen Produce Company, at Shanghai, employs in its breaking room some 600 girls, and they break approximately 1,000,000 eggs a day. With the present improved methods of egg handling and rigid inspection, it is practically impossible for a bad egg to escape detection by the keen noses of these trained girls.

Each egg is broken and smelled, and, if properly "fresh," is dumped from the small cup in front of each girl into a large container beside her. At each row of benches there is a supervisor, whose sense of smell is keener than the average. Each of these larger cans of eggs must be personally smelled by the supervisor before being passed on to a larger tank, whence a pump delivers the product to a central separating or mixing tank. The "chief smeller" of each establishment must approve the contents of each larger container before it is permitted to enter the mixing tank. It is said that the sense of smell has been so highly developed that many of these "chief smellers" can detect the presence of one bad egg in an entire tank of egg mixture.

Certain portions of the egg yolks are dried by patented processes, and certain portions of the egg albumen are dried for special uses. Large quantities of eggs, still in the shell, are frozen for shipment in crates, forming the bulk of China's egg exports. Eggs packed and frozen in China compare favorably in bacterial count with eggs produced in America, Europe, or in South America, since rules as to food inspection are rigidly enforced at Shanghai.

Pure Corn Sugar in Crystals

DEXTROSE, the sugar produced from corn, is proving of important industrial value since it has been made available in pure crystalline form. Long an important food staple, corn sirup, the form in which dextrose is first produced, has baffled attempts to obtain the sugar from it in perfectly pure crystalline form. The solution of the problem was finally reached as a result of a careful study of its habits of crystallization. The fragility of the crystals was overcome by conducting the crystallization at a temperature high enough to insure that the sugar would crystallize alone without water. By careful control of temperature and concentration of the solution as it crystallizes, commercial production of pure dextrose has been made to yield a product cheap enough for many new applications.

The possibilities of use of the new pure dextrose include, in addition to food uses,

KNOWLEDGE THAT HAS ENDURED WITH THE PYRAMIDS

A SECRET METHOD FOR THE MASTERY OF LIFE

WHENCE came the knowledge that built the Pyramids and the mighty Temples of the Pharaohs? Civilization began in the Nile Valley centuries ago. Where did its first builders acquire their astounding wisdom that started man on his upward climb? Beginning with naught they overcame nature's forces and gave the world its first sciences and arts. Did their knowledge come from a race now submerged beneath the sea, or were they touched with Infinite inspiration? From what concealed source came the wisdom that produced such characters as Amenhotep IV, Leonardo da Vinci, Isaac Newton, and a host of others?

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Comfort for a Hotel

INSTALLATION of what is declared to be the largest hotel air conditioning system of its kind in the country was completed recently for the Hotel Statler, St. Louis.

The new installation provides air conditioning for all of the lower section of the

One of the individual room controls in a hotel air-conditioning system

hotel, including lobbies, restaurants, private dining rooms, cocktail lounge, bar, barber shop, meeting and function rooms, as well as 300 bedrooms.

The Hotel Statler is the first hotel in the country to use air conditioning on such an extensive scale. For over a year, the Statler system has operated a number of types of installations of various manufacture. After considerable research in the field, officials of the hotel selected a system of individual Airtemp room conditioners which cool through the circulation of cold water.

The new system includes many newly improved features which, according to Airtemp engineers, mark a definite forward step in air conditioning development.

Chief among the new features is the Statler-Airtemp Regulator by means of which guests may control the extent of cooling and circulation of air within their rooms, according to their personal desires. The new instrument contains, in addition to thermometers which register both outside and inside temperatures, a control mechanism which permits the guests to regulate the degree of cooling and dehumidification as well as amount of fresh air coming into the room.

The Sourdough Goes Modern

IT is a far cry from the picturesque old sourdough prospector of 1849, who sought gold in the wastelands of the West with his meager supplies packed on burros, to the modern, scientific prospector of 1936, who seeks any and every kind of precious mineral with every known piece of equipment stored aboard a streamlined, powerful truck.

TAXES

THE automobile operator pays taxes of from 3½ mills to a little over 8 mills per mile, according to the differentials applied in his particular state.

The old sourdough sought only gold. When he found a deposit he believed to be gold, he had to stake a claim and rush to the nearest settlement or town to have his find assayed, and then had to spend long months determining whether his strike was valuable.

But today the modern, scientific prospector carries complete equipment on a motor truck and trailer, with sufficient supplies to let him live in comfort for several years, if need be, in desert or mountain. He is not only a prospector, but a minerologist, geologist, miner, and assayer. He is equipped with an assay furnace, diamond drills, scales, acids, and every modern instrument necessary to discover the worth of the mineral, the size of the deposit, and the kind of metal in the deposit.

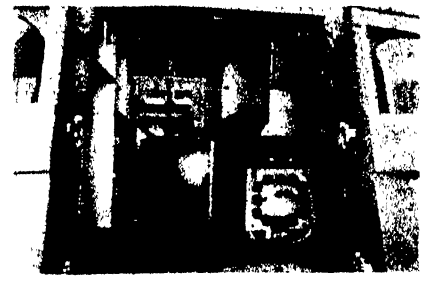
And the modern prospector seeks not only gold, but silver, beryllium, colemanite (borax), tungsten, oil, and every known precious metal in the deserts and mountains of the western United States.

Ernest A. Moross of Mosherville, Michigan, and R. B. Dennis of Cleveland, Ohio, are two such scientific prospectors. They believed prospecting scientifically would result in many "strikes" like those of other years. They dreamed and planned for many months of starting on a scientific expedition into California, Arizona, and the other western states where the country's great mineral strikes have been made.

Moross knew the success or failure of the trip depended on his transportation so he chose one of the new streamlined 1½-2 ton White trucks.

The truck was specially built to meet Moross' specifications. The extra equipment included a four-wheel drive; underdrive, 8-speed transmission giving 48 percent grade climbing ability; a 50-ampere generator; PPL booster for braking on mountain roads; air brakes; one-cylinder air-pump for inflating tires in the desert; No. 4-OB oil bath for protection in sand storms; puncture-proof tires and tubes; oil Purolator; a power take-off to run the generator from the engine to furnish electricity for the assay furnace, cooking, and refrigerating; 12 wheels—dual on front in emergency; special high traction differential gears in tandem axle; special four-shoe cable brake; five gasoline tanks with 140-gallon capacity; and six 50-gallon water tanks.

All of the above equipment is on and in the truck. The all-steel, streamlined body was built by Ernest Schaefer, custom body builder of Cleveland. The trailer is an all-steel Kabin-Koach built in Detroit. It has beds, refrigerator, plumbing, dinette,



The assay furnace and water tanks in the modern sourdoughs' truck

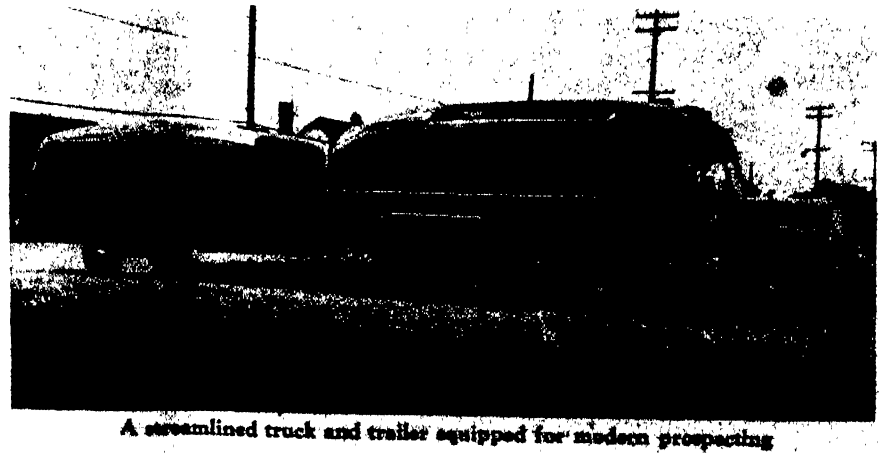
toilet, and storage space. The beds can be turned into soft-cushioned seats for daytime travel.

The final piece of equipment was a large tarpaulin which will be stretched over the truck, making a large tent under which the assaying and testing can be done, with the prospectors well protected from the sun and sand.

Wood to Yeast

UTILIZING the sugars produced in the process of converting spruce wood into paper pulp by the sulfite process, a plant recently put into operation in Nova Scotia produces baker's yeast as an important and valuable by-product from a material heretofore wasted. In the process of making pulp from wood, chips are cooked at high temperature with a solution of calcium and magnesium sulfites to dissolve out all those constituents of the original wood which are not cellulose. The resulting waste sulfite liquor from the pulping process contains lignin, proteins, resins, fats, and carbohydrates dissolved from the wood or formed during the cooking operation. For many years this waste has not only had little value but has actually been an expense to the paper maker who has had to dispose of it. The new method of utilizing sulfite waste liquor for the growth of yeast not only assists in the disposal of this waste but at the same time yields a profit.

The carbohydrates (sugars) in the waste liquor as produced amount to some 30 percent of the weight of the pulp produced

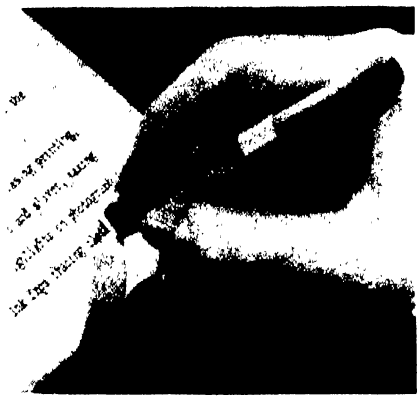


A streamlined truck and trailer equipped for modern prospecting

and about three fourths of this sugar content is fermentable. The process consists in neutralizing the liquor as produced with lime and soda, adding nutrients, and seeding with a pure culture of the desired yeast. After the yeast has attained its growth it is filtered from the solution, washed and dried. The quality of yeast produced is reported to be very high as compared with that made by other methods because of the fact that the sulfite liquor used is completely sterilized in the paper making operation, and hence contains no wild yeast to contaminate the product. The process was developed by G. Heijkenskjold, a Swedish engineer, and has been successfully employed abroad.—*D. H. K.*

Glass Again! It Erases

GLASS in many forms has found many new uses recently. It has now been given the job of erasing. Fibers of glass inserted in a holder as are the bristles of a brush provide numerous minute pin points which will erase India Ink, typewriting, paint, printer's ink, and is useful for pol-



Erasing with glass

ishing metal. It is made in a molded plastic holder which operates like an automatic pencil to propel the brush through the tip. It uses refills.

This device is more efficient than old ones of the same type as the fibers of glass are specially treated by a process to make them more flexible and bind them together slightly to eliminate much of the breakage. The brush is said to be softer and less likely to wear a hole through thin paper.

The Coldest Cold

NO one has yet reached the absolute zero of temperature, but by using liquid helium and the cooling effect of demagnetization at the low temperature which this produces, investigators have approached to within about one sixth of a degree of the lowest possible temperature. W. F. Giauque (pronounced Joke), of the University of California, described the method used and some of its results when he was recently awarded the Chandler Medal for his researches in the field of very low temperatures.

Using liquid air to cool liquid hydrogen and liquid hydrogen to cool liquid helium which in turn cools a cell containing a solenoid surrounding the material which is to be finally cooled, Dr. Giauque sets up a very strong magnetic field in the sample by means of the solenoid. When the heat of magnetization has been absorbed by the

(*Please turn to page* 176)

"Thar's Gold in Them Pages"

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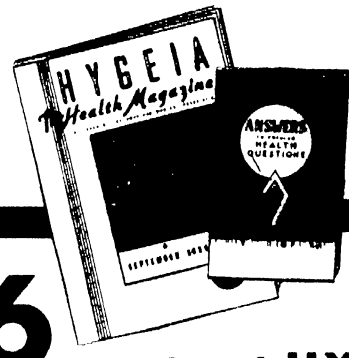

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Prospecting Around in the September Issue

Candidates for HEART DISEASE — Breakdowns in the functioning of the human heart are increasing so rapidly that one well may wonder whether he or she is a prospective victim. But, according to Dr. C. A. Cameron's article, if you are still under 40, and lead a rational life, you stand a good chance of escaping heart disease. This authentic article is a fine exposition of what to do and what not to do if the heart is to be protected.

●

PLAYWAYS To Health — Perhaps Grandpa didn't play a great deal, but actually he didn't need to. The pace of life then was that of the horse and buggy; today, that of the machine—speedy, relentless. But the human machine is still the same. "One of the best ways to relieve its tension is by 'the playway'", says Dr. Calvin T. Ryan. Upon reading his article, you will probably agree that, from the health standpoint, play is, after all, a serious business.

●

Food, Drug and Cosmetic RACKETEERS — "Crimes against society committed by food, drug and cosmetic racketeers are not so spectacular as those by gangsters, but more insidiously dangerous", says F. R. Winters, who has had a wonderful opportunity to see behind the scenes in this form of racketeering. His article tells about Banbar, a treatment for diabetes, Radiothor Certified Radium Water; "pain killers", dangerous beauty preparations and other products that menace both health and pocketbook.

●

A Wealth of OTHER ARTICLES — "How much home study?", the pros and cons as they relate to the health of the child. "Undulant Fever", a milk-borne disease discovered only within the last few years; "Snakes in the Service of Science", bound to increase respect for the serpentine creatures; "Home Not the Safest Place", showing almost 100 unsuspected ways to have an accident in the home.

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THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

EACH month, as we sit down to write up this department and run through a drawerful of materials sent in for publication, it is a question what to serve up; no wonder the ladies get tired of "thinking up meals." For several years we gave our readers a pretty steady diet of telescope descriptions, attempting at that time to

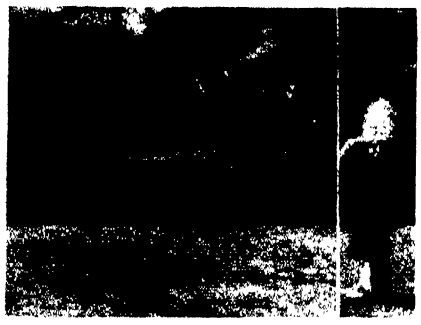

Figure 1: **Seely, folding scope**

publish all that came in, since we had included in "Amateur Telescope Making" an invitation to send them to us. In more recent years their numbers swamped us and we gave up this intention, regretfully removing the invitation from "A.T.M." and selecting especially outstanding telescopes for description. This, however, somewhat leads to the discouragement of the new recruit to the hobby, who is not likely to branch out into fancy work on his first telescope and who may not care, for that reason, to be high-hatted by seeing only Rolls-Royce class jobs described. We hope our following will continue to send in photographs of those telescopes which have original features of merit, whether they are big telescopes or little, beautifully finished or rough, for the features themselves are the essence of it, provided there are any.

Speaking of photographs, here are a few notes on the practical end of making them for publication, as checked over by our layout and make-up editor, who often groans about some of the art (editorial lingo for illustrations) we hand him with the request that he do a miracle in reproducing it.

WITH the most thoughtful intentions many persons break our partly Scottish heart by going to the added expense of having enlargements made from photographic negatives which they make of telescopes and so on, because the ordinary size prints do not seem to be sharply in focus. Wasted money! If the original negative is not sharp, enlargement only makes matters worse—the fuzziness is enlarged with the rest. Then, when we have half-tones made for reproduction from these fuzzy enlargements, they have to be reduced—possibly to the original negative size—and we are right back where we started, only a little worse off. There is always some loss of definition in a half-tone reproduction. Hence, if we have to start with a fuzzy print, the reproduction will be proportionately worse than from a clear sharp print.

The game can't be beaten by enlarging fuzzy negatives. But fine half-tone reproductions can be made from sharp contact prints of almost any ordinary size. Of course, if you use 35-mm or "half vest-pocket" film in your camera, it is preferable to enlarge to 3 by 4 inches—a photographic enlarging camera usually seems to do a better job than the engraver can do when making a half-tone negative. If, however, your camera takes negatives 2¼ by 3¼ or larger, concentrate on getting sharp negatives and send us contact prints on glossy paper. "Spend the difference between the cost of contacts and the cost of enlargements on a drink—ice cream soda, of course." So our layout editor suggests, and, he adds, "While we are on the subject of photos: When 'mugging' your telescope or whatever, look to the background as well as the subject. A telescope, for example, photographed against a background of trees or buildings of approximately the same general tones as the scope will be quite successfully camouflaged. If possible, set up a background of neutral tone—an old bed sheet is

Figure 2: **Bartlett, wooden tube**

fine—or try shooting against the sky. The subject will then stand out like a sore thumb, without distracting or camouflaging objects in the background."

GETTING back to telescopes, Figure 1 shows a simple one of conventional 6" beginner's size but it has a feature: it jack-knifes. Roy A. Seely, 3818 Spuyten Duyvel Parkway, New York, N. Y., who lives in an apartment house where every cubic foot of space is expected to store two cubic feet of something, is the maker. The "spinal colyum" is hinged amidships and folds when the owner decides that Jersey mosquitoes have made the New York park uninhabitable and wants to go home. Unfortunately the little picture at the right was trimmed, involving the upper half of the telescope, but it still shows the folded telescope feature. The short end tubes exclude stray city light, and rubber base pads shunt off city vibration, for New York trembles at all times: subway trains and heavy trucks.

FIGURE 2 is a 9" wooden tube reflector made by Clifton W. A. Bartlett, Pembroke, Maine. In fact, he says, the whole rig is wooden, with the exception of one bolt. He points out the eyepiece end feature: "I cut two slots, one on either side, into which the eyepiece assembly slides, with a blank in the other slot. Thus you don't have to break your neck observing." This feature also permits taking the eyepiece and diagonal indoors without complication. The double yoke type of mounting is a neat, clean-looking type, especially rigid, easy to build, and inexpensive. We urge the construction of more of them. A relatively small drawback is that a little patch of sky around the Pole is out of reach.

AMATEURS in Indianapolis, Indiana, are incorporated into the "Indianapolis Amateur Astronomer's Association," Victor E. Maier, 1306 Parker Avenue, being the energetic secretary and he wants the world to know that Indianapolis is in, of, and on it. He writes: "Our group is constantly growing, the number in good standing now totaling 93. Better telescopes all the time.

"One of our members, Dr. L. F. Smith (D.D.S.) has finished an 8" Springfield of superlative design and workmanship. I enclose his photo (Figure 3). Some of the machining on this job required real hocus-pocus. The machine work was done by our ace machinist Harry Jordan. This particular instrument has several innovations. In order to get his necessary portability the entire assembly is made of aluminum, with the exception, of course, of the detachable counterweight and braced arm and the gears. The 'friction drive' is very accurate, such that the telescope can be pointed in any direction quickly, and the slow motions used immediately without loosening or locking. The offset hand wheel in R.A. gets away from limitations in driving when west of the meridian. The cast-iron worm gears

Figure 3: **Smith, Springfield type**

Figure 4: **Smith's hand drive**

and steel worms were cut by Mr. Jordan. They can be driven in a complete circle. The diagonal holders and focusing device are of the 'Jordan design' and permit easy, accurate adjustment. The Pyrex mirror, which Dr. Smith finished, possesses one of those rare 'lifesaver,' smooth figures, with the 'crest' at the proper place. All told, we believe this to be a very outstanding instrument. In the close-up (Figure 4), note the offset hand drive for R.A. It allows much greater degree of rotation. Fiber friction disks sandwiched between the gears (home made) and aluminum castings do away with locking devices."

SHOP NOTE: When, in polishing and figuring, it seems impossible to get a sphere, try abandoning the very short strokes recommended elsewhere and substitute long, firm, fearless ones. We discovered this accidentally when we got mad and didn't longer care what happened, and since then two others have tried it and likewise found it did business. *But*, it requires a good hard lap—no mush (Everest scale one pound pressure, finger nail, ¼" mark, 20 seconds or more), and this in turn requires rouge that hasn't scratched yet. We found it possible with this to extend the strokes to equal full diameter of mirror in their total sweep, without turning the edge. Avast, then, with fiddling, timid little one-inch strokes to get spheres. Instead,

Figure 5: **Prescott's portable**

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Figure 6: **Prescott's clock drive**

get mad at 'em. Try it at *your* risk, and please report findings, since it might have been our own bad language, and not the long strokes, that did it.

THE 6" portable telescope with welded pipe stand, shown in Figures 5 and 6 and made by Fred L. Prescott, 3111 Brooks St., Dayton, Ohio, deserves commendation on the score of its declination axis, which is large enough at the bottleneck, and the same strength is carried through to the tube. Too often mountings which have a sufficiently large declination axis at the bottleneck, have this same large axis shaft attached to a light plate on the tube—thus wiping out the gain in rigidity conferred by the large axis shaft. Here, however, the design is consistent, straight through. The wing nuts that show on the flange near the polar axis are attached to the ends of metal bands passing around that axis; the end of the polar axis does not quite touch the declination axis (hidden, in the photos shown here).

Outside of the simple yet rigid latitude adjustment, also with wing nuts, the chief item is the clock drive, about which the maker writes: "The polar axis turns in a tube with suitable bushings, which in turn rotates in the polar axis housing. This tube has a 5" drum at the lower end, over which a stranded wire cable (airplane control cable) passes, making 1½ complete turns. The clock, an old alarm clock, has the spring removed and a 1¼" drum fitted, with the cable passing around it several turns and fastened to the drum. On the other side the cable winds up on a ⅞" drum to which an 8-day spring is connected. The spring thus draws the cable in, turning the polar axis bearings in sidereal time, the clock escapement regulating the speed. The 4:1 ratio is just right, since the key of the clock makes four complete turns in 24 hours. The diameters given are "pitch diameters"—to the center of the cable.

"To the 5" drum is attached an index reading against the hour circle, and thus, once set on some known star, right ascensions are read without correction for local time throughout the evening, as in 'A.T.M.' p. 145. The upper polar axis bushing must incorporate the flange against which the thrust comes, otherwise the telescope will not run positively with the tube and bearings. No lock is required, the telescope being turned freely to an object which it follows until moved to another."

Mr. Prescott also describes a hard lap which he has used: "A smooth piece of cotton cloth is stretched over the tool. Bits of beeswax are laid over the lap and the whole slowly warmed in the oven until the wax melts and saturates the cloth. The excess wax is removed with a piece of cloth. The edges are notched about ⅜" deep, about 1" apart, all around, to guard against turned edge. This lap works from the edge inward, because the radius of curvature of the lap is about .005" to .010" greater than that of the mirror. With good rouge, this lap is fast and about as free of scratching as HCF. It has the advantage that its radius does not change during the polishing, and it works very smoothly." Mr. Prescott sends along two ronchigrams indicating very good workmanship. We have not tried out this lap but see no reason to doubt its value.

With regard to notching the circumference of a lap to guard against turned edge, this is a common expedient though, properly speaking, it is a sort of makeshift and compromise. The notching out is likely to make a transition zone, being mighty hard to do just right. However, we confess doing this same stunt, even though it is a frank confession of something or other suspiciously like not knowing our trade or not having much pride in it. A good hard lap ought not to turn an edge, even when not notched out. All this advice is cribbed from the most expert mirror maker we know, Wally Everest; it was he who first gave us Hell for using notched out edges on laps.

Figure 7: **The Duxbury model**

A THIRD portable or semi-portable telescope—an 8"—which is very finished in appearance but embodies something of the type of attachment plate at the tube, which was mentioned above, is shown in Figures 7, 8, and 9. Figure 7 was published some months ago but without any detailed information. The maker is Dr. M. N. Duxbury (another D.D.S.), 805 Bellin Building, Green Bay, Wis. Dr. Duxbury sent several large, detailed blueprints, but these could not be reproduced here; besides, we are still stubbornly "sot agin" the blueprint idea. If any wish to copy this telescope they may obtain blueprints direct from the

Figure 8: **Duxbury detail**

maker. The telescope is one of the most finished in outward appearance we know of.

The truck (Figure 7) has three leveling screws used in connection with level vials. It has a removable tongue. Quite a few amateurs are so situated that their telescopes must be taken out of doors, and a truck mounting of this type is almost the only solution where a fairly heavy telescope is desired.

Figure 8 shows the clock motor, made by the United Air Cleaner Corp, Chicago; it is a United Phonograph Motor, Blue Flyer Model. The gear box contains two worm gears, a gear, and pinion, and the maker has the patterns, which he states may be rented. The hand wheels are sewing machine fly wheels.

The controls are all within a short radius immediately beneath the eyepiece. The details of the declination and R.A. slow motion controls shown in Figure 9 are of much interest and warrant close study.

Another interesting feature is the tube, which will rotate without a wrestle, as there are roller bearings between it and its retaining bands.

The truck assembly was made by the Green Bay Vocational School, under the direction of Mr. Edward McMonagle, the tube by the same school under the direction of Mr. Thorpe. The eyepieces, mirror, and diagonal were made by Mr. C. T. Elias, and the silvering was done by Dr. Stephen F. Darling, both of Appleton, Wis.

Figure 9: **Duxbury slow motions**

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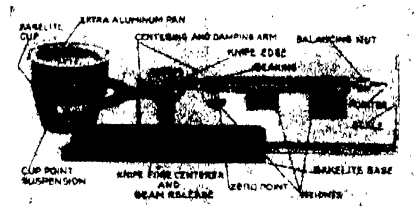

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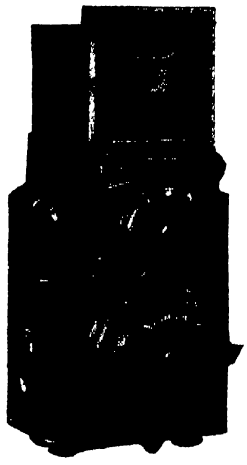

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"Minicams" Grow In Favor

THE growing legion of miniature camera users among newsmen was recently augmented by the Associated Press' purchase of ten F:1.5 Contax units. The Contax and Leica distributors have had quite a job on their hands breaking down the "sales resistance" of the newscameramen with regard to using the miniature camera on their regular assignments to cover subjects difficult or impossible to tackle with their regular 4 by 5 cameras. But success now seems assured, for these tiny outfits have demonstrated their worth time and again, especially on indoor night assignments where the bulk of the larger outfit is too cumbersome to handle in tight situations.

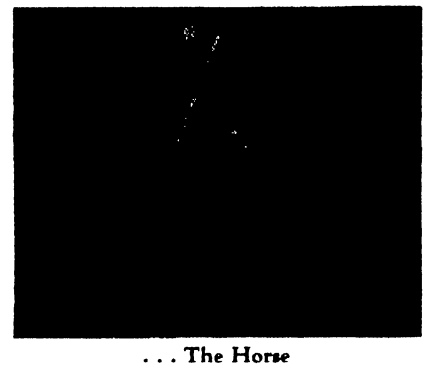
From the same source it was learned that a considerable number of Leica cameras have been bought by a group of explorers equipping themselves for a long journey and to whom the pictorial record of their findings will be the most valuable "game" they plan to bring back with them.

Fighting Superstition With Cameras

AN interesting sidelight of the recent eclipse which drew to Siberia many scientists from distant lands to witness and study the great solar event was the sale of several hundred thousand low-priced cameras to the masses to enable them to make individual recordings of the phenomenon. The cameras sold for a few rubles each and their distribution was in line with the Soviet Union's fight on superstition. In addition to the cameras, millions of pamphlets printed in the many languages spoken by the different nationalities comprising the Soviet Union were handed out and hundreds of university lecturers traveled throughout the country explaining the eclipse to the people.

A Word for the Horse

THE city horse, dragging out a burdensome existence pulling delivery and fruit-peddlers' wagons from dawn to dusk, is worth occasional photographic attention.



. . . The Horse

In the main, he makes a rather unattractive subject, but now and then he may be seen, as in the above illustration, in a characteristic situation worth recording. The picture was made in New York City from the platform of the elevated railway.

Photographing the Abstract

THE photography of intangible ideas offers the serious hobbyist, eager to try "something different," one of the most interesting, albeit one of the most difficult, phases of camera activity. Both stimulating and challenging to inventiveness, it calls for imagination and the ability to state photographically—that is, in material, visible form—that which exists only as an abstraction. The commercial photographer assigned to create an advertising photograph for one of the "service" type of companies, that will express some such idea as reliability, strength or dignity, draws on all his resources to turn out a job fitting the occasion. How well he succeeds depends, to a great extent, on how much time he can give to thinking about it.

Thought, then, in terms of symbols, is the main thing. You know what you want to say. But how to say it? You look about your home, stare into shop windows, watch children at play, realizing that you do not know exactly what you seek but that when it appears you will recognize it. You will sit musing at the dinner table, toying with sugar cubes, tooth picks. It may prove

discouraging work but it should not be pursued doggedly; rather, if allowed to develop subconsciously, an unexpected moment may produce the answer.

The idea finally decided upon must be simply expressed, direct, so that it will be easy to understand. Simplicity, however, is difficult to achieve, whether in writing or photography, so that much reliance must be placed on the lucky inspiration. But inspiration springs from thought, so the more

"Finality"

we think about a subject the greater the chance of the inspired "spark." Developing a sense of observing symbols in ordinary human gestures, in humdrum, daily routine, will do much to make facile the invention of palpable subject-matter capable of signifying an abstract idea.

The two examples illustrating this discussion may clarify things to some extent. "Finality," for instance, depicting the burning end of a stick of sealing wax as it is being applied to the flap of the envelope, symbolizes an irrevocable act. For better or worse, right or wrong, wise or foolish doubt, indecision is over. The deed is conclusive; it is finished, final. "Leisure" attempts to carry out the idea in the curtained window, the soft illumination of the curtains, the assorted accessories on the table, and the man reading a newspaper. The picture might have been merely a study of a man reading a newspaper; as it is, however, the man is but part of the whole, indispensable though he is to the full expression of the idea of leisure. He is absorbed in his reading and is apparently in no hurry to finish with it. There are many hours ahead and no work until the morrow.

The idea must come naturally, without straining, for a labored device will in most cases carry with it the serious stigma of heavy-handedness, therefore abstruseness. Beware of overlooking the obvious. Be alert for the ready-to-hand subject that calls for no more preparation than the aiming of the camera. If you have to "set up" your subject, use the fewest accessories necessary to get your idea across and use light in the most effective manner to give due emphasis to the most "telling" feature of the composition. Shadows are very forceful in this type of picture and a simple object, made to throw a long shadow, will sometimes serve better than a more elaborate setting.

There is much real satisfaction to be gained in devising photographic abstractions for the worker who sees in his hobby something more than a means of recording the run-of-the-mill subjects.

New Photoflood Size

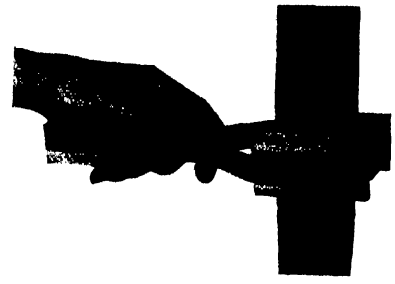
A NEW Photoflood bulb size producing twice as much light as the present Mazda Photoflood bulb and with triple the life of the latter is announced by the General Electric Company. Like its less powerful predecessor, the new bulb, which consumes 500 watts and resembles the standard 150-watt inside-frosted Mazda lamp both in bulb size and appearance, is used on the ordinary house circuit. While the new Photoflood was developed for the use of the commercial and portrait photographer, it will be found very useful to the amateur photographer.

Compact Lighting Outfit

AN inexpensive portable lighting outfit, capable of furnishing proper and generous illumination for a great many types of subjects is being offered by the Testrite Instrument Company. "The Ideal Studio and Home Outfit," as it is called, fits into a carrying case and includes the following

"Leisure"

The WILLO
FILM DRYER



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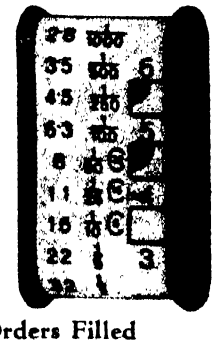

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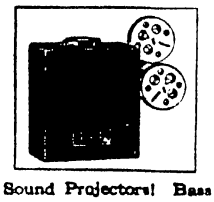

Sound Projectors! Bass handles them all—RCA VICTOR . . . BELL & HOWELL . . . VICTOR ANIMATOPHONE . . . and AMPRO. Write for quotations.

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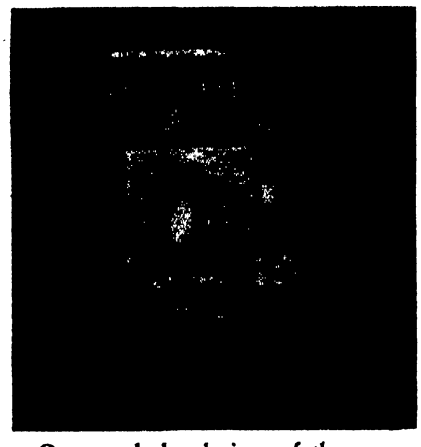
equipment: Four 2-socket 10-inch reflectors and two 3-section folding stands rising to a height of more than 8 feet and with adjustable swivels on the cross bars to permit directing the lights at any desired angle; four diffusing cloths and clips; and a 25-foot extension cord. With the four reflectors accommodating a maximum of eight Photoflood bulbs, this fund of lighting should be sufficient to take indoor snapshots even with the slower lenses or with the faster lenses considerably stopped down for depth when this is found desirable or necessary. The advantage of the carrying case arrangement is the easy portability of the entire lighting outfit.

Another Miniature

INTRODUCING a new Eastman lens—the Ektar F:2—the Rochester company has put on the market the latest miniature camera—the Kodak Bantam Special. Featured by a built-in, synchronized range finder of



Open and closed views of the new Bantam Special miniature with F:2 lens and a built-in range finder

the military split-field type, the camera weighs but 16 ounces and is enclosed in a die-cast and machined aluminum case shaped for convenient handling and finished in a new-type baked enamel of unusual toughness. When closed, the case provides complete protection for the lens, shutter and front elements of the view-finder and the range-finder.

The Ektar F:2 is an anastigmat of 45 mm. focal length, the range of the diaphragm openings being from F:2 to F:16, with the depth of focus at 10 feet and the smallest opening so steep that all is in focus

Build a Photographic Library

Leica Manual, *by Willard D. Morgan and Henry M. Lester.* A beautiful book of over 500 pages dealing with all phases of miniature photography. It covers such subjects as panoramas, photomicrography, dental, stage, and aerial photography, photomurals, infra-red, and many others. $4.00.

Practical Amateur Photography, *by William S. Davis.* Deals with the whole subject from the origin and growth of photography to the latest types and uses of cameras. 264 pages, illustrated. $2.40.

Photographic Enlarging, *by Franklin I. Jordan.* A complete treatise on enlarging, discussing not only the necessary equipment but all of the darkroom processing dodges which may be employed, combination printing, mounting, and lantern slides. It is written in a light yet thorough-going manner. $3.70.

Free-Lance Journalism With a Camera, *by Rufus H. Mallinson.* Many serious amateur photographers would like to know how to make money with their cameras; here is a complete guide to that work. It tells not only how to make salable pictures but also how to market them. $1.65.

The Fundamentals of Photography, *by C. E. K. Mees.* Not only tells how to take and finish pictures but gives a solid foundation of the principles of photography. $1.10.

Portrait Lighting, *by Frank R. Fraprie.* Takes up the rapid development in the last few years of artificial lighting for indoor photography. $2.15.

Modern Development, *by F. R. Fraprie.* Describes all methods of development, stressing particularly modern factorial and thermo methods. All formulas are given. $1.10.

Camera Lenses, *by Arthur W. Lockett.* Explains simply and clearly, yet with scientific accuracy, all the underlying principles of lenses. 85c.

Infra-Red Photography, *by S. O. Rawlings.* A treatise on the use of photographic plates and films sensitive to infra-red. Exposure and processing are fully covered and many formulas are given for sensitizing. $1.65.

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from 4½ feet to infinity. The closest focusing distance is three feet. The Compur-Rapid type of shutter with which the camera is equipped has nine speeds, from 1 second to 1/500th of a second, as well as time and bulb action.

The film locks automatically in centered position for each exposure and a specially designed film pressure plate gives uniform film register. The camera is 4⅞ inches long, 3⅛ inches wide, and 1 13/16 inches thick; it uses eight-exposure roll film of two types, Panatomic—F828—which is a medium speed panchromatic film, or Super X—X828—high speed panchromatic.

After the Rain

A GREY rain-soaked scene comes suddenly to life as the sun peers momentarily through a rift in the clouds. The main highlight in one of the "strong" positions,

"After the Rain"

the varied direction of diagonal lines, the soft highlights on the automobile tops, the resumption of natural movement after the downpour, the bootblacks once more in their places—all is adequately rendered to reproduce the mood of the moment.

New Speed Graphic Size

THE newscameraman's 4 by 5 Speed Graphic, some time ago made available for amateur workers in the 3¼ by 4¼ size, has recently been placed on the market in the 5 by 7 size. This size is quite popular with pictorial workers who like to use the view camera type, which the Speed Graphic resembles in some respects.

Express "Chrome" Film

A FINE-grain orthochromatic film possessing such speed that pictures may be taken with it even in weak light and on dull days is the new Gevaert Express Superchrome Rollfilm, which is also available in filmpack and 35 mm. "miniature" sizes. To help users of their film in attaining a fair percentage of correct exposures, the manufacturers offer the following convenient exposure table:

	U.S. No.32 F:22	U.S. No.16 F:16	U.S. No.8 F:11	U.S. No.4 F:8
Bright Sun	1/25	1/50	1/100	1/200
Faint Sun	1/10	1/25	1/50	1/100
Bright Cloudy	1/5	1/10	1/25	1/50
Dull Cloudy	1/2	1/5	1/10	1/25
Rainy	1	1/2	1/5	1/10

It is suggested that a tripod be used for all exposures made at speeds below 1/25th of a second.

You will notice that each larger opening for any given condition of light is, of course,

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Zeiss Lenses and automatic range-finder-focusing produce needle-sharp negatives with all the detail and tone values that make a picture "sing".

Contax is now available in two models, Contax I (black finish) and a new Contax II (Chromium finish), which at slightly higher price offers new features. At leading dealers.

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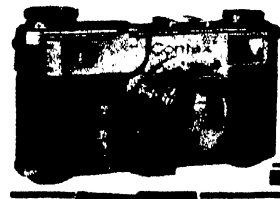

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Congratulations to Robert N. Bushman! See his prize-winning GRAFLEX "shot" on page 136 of this magazine. . . . Then ask your dealer to show you the many exclusive features of the GRAFLEX Series B and other GRAFLEX American-made cameras that are capturing practically all of the prizes in all of the important amateur and professional contests—and be sure to see the Graflex ENLARG-OR-PRINTER and Franklin I. Jordan's fine book on "Photographic Enlarging."

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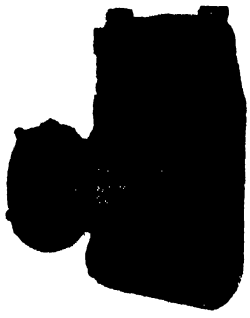

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HERE is a precision picture maker that is inexpensive and simple to operate. It takes 16 pictures 1¾ x 2¼" on ordinary rollfilm. The celebrated Rudolph "Plasmat" f2.7 lens ensures excellent definition and depth of focus. The delayed-action Compur Shutter provides 11 settings up to 1/250 sec. or 1/400 sec., fast enough for sports pictures. The built-in range finder permits of critical focusing by rotating a convenient ring on the lens barrel. The all-metal housing is covered with fine grain leather and chromium finished. Weighs only 25 ozs., fits a coat pocket, and may be had with a carrying case of brown saddle leather, or a convenient Ever-Ready case, permitting pictures to be taken without removing it from the case.

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exposed for half the time of the preceding smaller opening, so it will be a simple thing to estimate the proper readings for diaphragm openings on your camera other than those appearing in the above table. You will notice, too, that the various speeds for the different light brightnesses "double up" on each other as the illumination becomes weaker.

Bottle Washing

SOME of our readers may have thought of this already, but if you have not, you will find the use of a spray attachment for the faucet a very useful tool for washing out the insides of bottles. A dime buys a good one. Bottles should be thoroughly rinsed out after being emptied and before they are re-filled; the spray offers an effective means of doing this. Trays may also be rinsed this way after each processing session and again just before they are filled with developer and fixing solutions; they are bound to gather some dust between periods of use.

"Miniature" Depth

THE extreme depth of focus of the 2-inch "miniature" lenses is illustrated in the accompanying photograph. This was made at F:12.5, 1/20th second, on "superpan" film, from a crouching position below

Depth with a miniature

the canopy framework. The advantage of getting all planes practically equally sharp at so short a distance—about 15 feet—from the nearest plane makes the "candid" type of camera useful in many instances where other equipment would fail miserably.

Buy or Build?

THE question is frequently asked whether it is not cheaper to buy one's photographic accessories than to build them. Such a statement cannot be answered with a blanket reply of "yes" or "no" because several factors are involved. What, for instance, is meant by expense? Money or time? From the dollars and cents viewpoint, it may be cheaper to "make it yourself" but it will, of course, involve time—in some cases, a great deal of time. It is taken for granted, of course, that the home-made article will be made so well that it will work as effectively as the purchased one.

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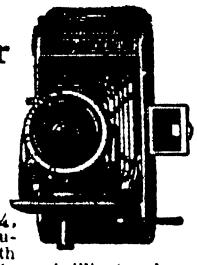

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Another point to consider is the "make-up" of the builder himself. There are some self-sufficient people, sometimes known as the "handy-man" type, who will never buy an article that they can possibly make themselves. With such persons, the expense of time will be offset by the satisfaction derived from making the desired gadget.

Then there is the factor of whether the accessory in question is available on the market. Certain photographic problems are so peculiar and unusual that nothing remains for the worker to do but to make the required tool himself or to go without it.

For Limp Prints

THE bugaboo of curled prints is being shooed away by some workers through the use of a glycerine bath between the washing and the drying. The bath gives to the prints brilliance and the requisite limpness for easy handling and mounting. The prints are immersed in the following bath for one minute and then dried in the usual way:

Glycerine	1 part
Water	19 parts

Miniature Printer

A PRINTING box furnished with an adjustable mask for printing negatives varying in size from 2¼ by 3¼ inches down to the 35 mm. size is now on the market, in which negatives may be used either in strips or cut into individual exposures and held securely under the masks while the paper is adjusted into place. The Miniature Printer is an adaptation for miniature camera workers of the larger professional printers.

Honorable Mention

IN addition to the three prize winners in the SCIENTIFIC AMERICAN photograph contest, announced on page 136 of this issue, ten honorable mention prizes, each a one-year subscription to SCIENTIFIC AMERICAN, were awarded to the following:

Stephen S. Slaughter, New York City; Al S. Oliger, Seattle, Washington; Wm. Edwin Booth, Richmond, Virginia; C. H. Freeman, Ottawa, Ontario, Canada; John D. Briggs, Ridgewood, New Jersey; Bory Osso, New York City; A. W. Prasse, St. Louis, Missouri; Walter Krauss, Clifton, New Jersey; Irving Herman, Manchester, New York; Tom Recker, Penysburg, Ohio.

Other examples of excellent work, selected from among the many photographs entered in the contest, were submitted by: Wm. Beardsley, Newport, Rhode Island; Celia Spalter, New York City; C. N. Joyner, Tientsin, China; Harold Robert Stamm, West Allis, Wisconsin; Geo. A. Hilbert, Ridgewood, New Jersey; M. L. Pool, Columbus, Ohio; Harland L. Swift, Santa Monica, California; G. Frank Zimmerman, Cranford, New Jersey; John B. Lurvey, Manchester, New Hampshire; C. C. Balke, Highland Park, Illinois; Thomas F. Mulry, Shelton, Connecticut; Edward C. Day, San Anselmo, California; Charles Dowell, Hoquiam, Washington; Mrs. Dorothy E. Calder, Harvard, Massachusetts; Werner von Bergen, Clifton, New Jersey; Ted White, St. Petersburg, Florida; Edward Eaton Kimball, Farmington, Maine; S. A. Meloslavin, Chuquicamata, Chile, S. A.

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The Fundamentals of Radio

By R. R. Ramsey, Ph. D., Professor of Physics, Indiana University

The first edition of this valuable text book appeared in 1929. Now the second edition has been published, bringing the whole subject thoroughly up to date. The book was written as an elementary text for college students but it can be read with profit by anyone who has a fair background knowledge of electricity and elementary mathematics. True, the author introduces calculus in a few places but the reader who is not familiar with this phase of mathematics can pick and choose. The text is thorough-going, from an explanation of direct and alternating currents right straight through to the very latest types of multi-element vacuum tubes and television. This is not in any sense a "how to make it" book or a compilation of various "hook-ups." Rather it is a solid, meaty exposition of the principles underlying the many phases of radio. 426 pages, well illustrated, and printed on good paper.—$3.50 postpaid.

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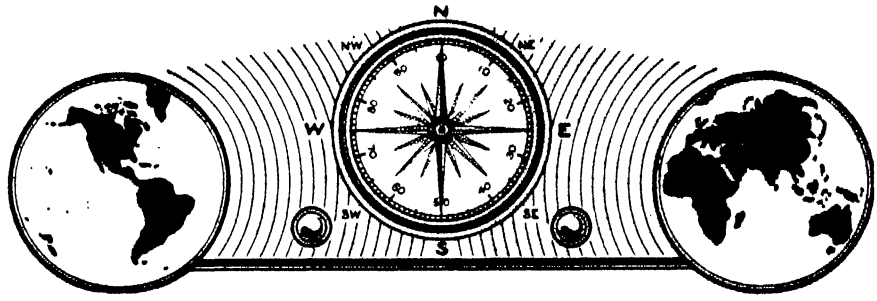


WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN
Editor, *All-Wave Radio*

"Veries"

THE hobby of all-wave DXing has more to it than just the reception of conversations and programs from distant 'phone and broadcast stations. Indeed, to many listeners, a very real interest lies in collecting verification cards.

Verification cards—"veries" for short—are obtainable from most of the domestic and foreign standard and short-wave broadcast stations. Such a card is not only an acknowledgment of a reception report, but is a documentary proof of your reception of a program from the station providing the card. It is clear from this that stations send verification cards only when they are satisfied that you have actually intercepted one of their programs. Proof of reception is therefore required.

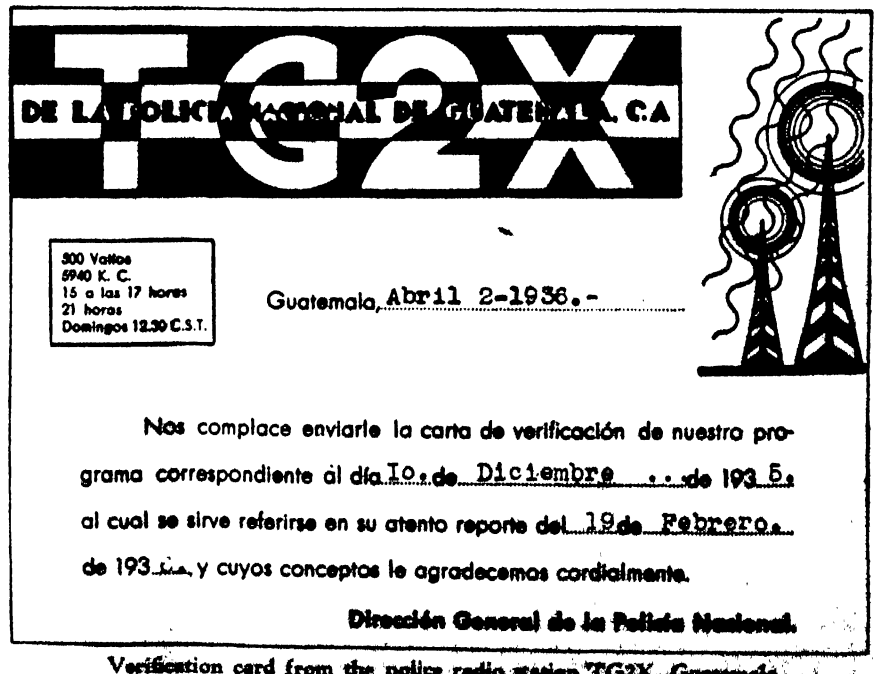
If you caught a fish "this big," or made a hole in one, you require evidence or your friends will accept your remarks with more than a grain of salt. But if you pick up VK2ME, in Australia, or JVM, in Japan, or most any other distant station, you can obtain the evidence right from the stations in the form of verification cards addressed to you.

Some of the cards are very attractive, and some are very rare, though none have monetary value. Nevertheless, there is as much of a thrill in collecting veries as there is in collecting stamps—and it costs much less.

How do you get hold of them? Well, suppose you pick up an orchestra playing, let us say, "The Blue Danube," and later, say, "Swamp Fire," and finally you hear the station announcer refer to VK2ME. It's a pretty good shot, then, that you have listened to Australia, and the orchestra pieces together with any other selections or remarks you heard constitute proof.

The thing to do, then, is to write to the station, giving as many details as possible regarding the reception. This should include the date and time heard, the station call letters, the frequency or wavelength on which the station was received, whether there was interference from another station (give the call if you know it), whether the program was interrupted by natural static, whether the signals faded, whether periodic distortion was noticeable, whether the general quality of reception was good, and the signal strength. The last should be stated in "R" units, which are as follows: R1—just audible; R2—very weak; R3—weak but understandable; R4—fair; R5—fairly strong; R6—strong; R7—very good signal; R8—very strong; R9—extremely strong.

Thus, a report might run as follows: "Your station VK2ME was heard by me on July 1st between the hours of 8 and 9 A.M., E.S.T. on a frequency of 9590 kilo-



Verification card from the police radio station TG2X, Guatemala

cycles. No station or static interference noticeable. Signal fading varied between R7 and R9. Average signal R8. Distortion noted during signal fades. Quality (clarity) excellent. I employ a Model 000 Blank All-Wave Superheterodyne with a doublet antenna running north and south. . . ."

The above should be followed by at least a partial list of what was heard, such as musical selections, talks, and so on, and concluded with a request for a verification.

It is very important that you list some of the things you heard. Some people attempt to obtain verifications by copying the programs printed in newspapers, or by merely stating that they heard the station at a specified time. This has made it necessary for the stations to exercise care in issuing verifications, and you are not apt to get one if it appears that there is a possibility you never heard the station at all.

It is also advisable that the technical data be accurate, and not colored by your desire to sound pleasing. If the signal is poor, or weak, or fades badly, by all means say so . . . this is just what the station engineers want to know, and it is only through such data that they are able to improve services. That's the reason they want such information.

The letter should be addressed to the station. Usually the station call, the city, and the country are sufficient, but if you want to be on the safe side, consult the lists of station addresses published in radio magazines.

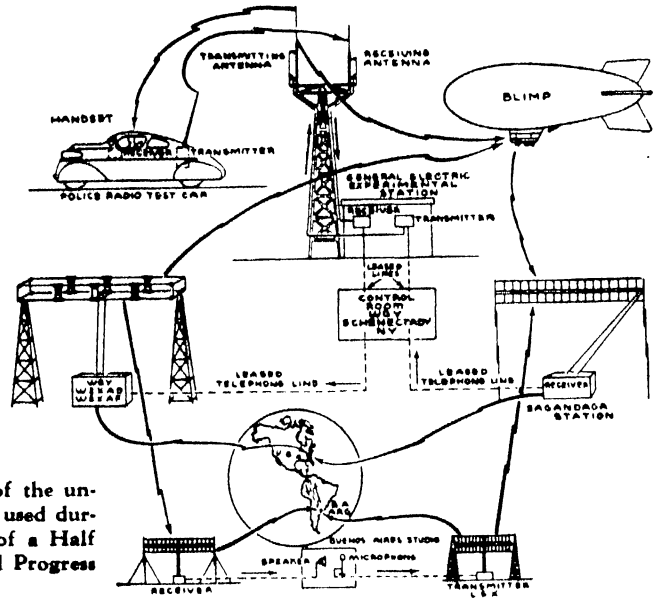
Each request should be accompanied by an International Reply Coupon. These can be purchased at any post office—at nine cents each. They are acceptable in most countries, but they need not be sent with a request addressed to any station in the U.S.S.R.

Veries—called "QSL cards" by radio amateurs—can also be obtained from amateurs in this and foreign countries. However, the radio amateur is not apt to send a verification unless your request for one is accompanied by a detailed report regarding your reception of his signals. It is neither necessary nor advisable to include a statement of what you heard, other than the call of the station with which he was communicating, but it is only fair that you give him a report to compensate him for his trouble in mailing you a card. The report is as valuable to him as it is to the broadcast station engineer, for by such reports the amateur can determine his field pattern, and correct it if it is not to his liking.

In requesting verifications, keep in mind that no one is compelled to provide them. It is a courtesy, and an expensive one for most stations.

Novel Radio Hook-Up

During the celebration of Schenectady's Half Century of Electrical Progress, a novel radio hook-up was employed to provide two-way conversation between the Goodyear blimp *Resolute* and a General Electric police radio test car roving the streets. Theodore Van Deventer and Ernest J. Berggren, two Edison Pioneers who were early co-workers of the great inventor, discussed the work done by Edison in 1875 on wireless telegraphy, and afterwards talked with station LSX in Buenos Aires, a distance of more than 6000 miles.



Simplified drawing of the unusual radio hook-up used during the celebration of a Half Century of Electrical Progress

The accompanying sketch shows how this was done. The mobile radio equipment used in the blimp and car operated on ultra-short waves. Signals transmitted from the blimp were intercepted at the Sagandaga station and fed to the control room of WGY by land line. The signal was then transmitted from the General Electric experimental station to the police radio test car. The signals transmitted from the police car were intercepted at the experimental station and relayed to the blimp through transmitting station W2XAD. This same signal was intercepted at the receiving station at Buenos Aires and re-transmitted to the Sagandaga station through the LSX transmitter. By this means a complete circuit was made available.

New Soviet Station

A new short-wave broadcasting station has been placed in operation in Moscow. The call is RAN. This station is being heard well on the east coast on a frequency of 9520 kilocycles (31.51 meters). There are daily transmissions, broadcasts in English being from 7 to 7:30 P.M., Eastern Standard Time.

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Marks' Polarized Eyeglasses are now available for normal eyes as plano glasses mounted in attractive frame, including case.

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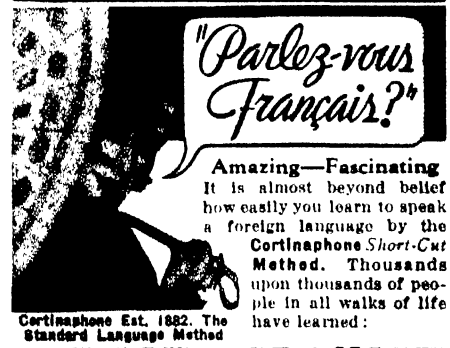

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 163)

liquid helium, the space surrounding the sample is evacuated to make it a heat insulator and the magnetic field is removed. In demagnetizing, the sample cools itself still farther. In this way the lowest temperatures yet attained are reached. The material cooled is one ordinarily considered non-magnetic.

Absolute zero of temperature is 273.13 degrees below zero, Centigrade (−459.4 degrees, Fahrenheit), and at that point heat ceases to exist and all motion of molecules stops, according to present theory. As a result of attempts to reach this coldest cold, the possibility of separating different kinds of atoms of the elements (hydrogen and oxygen, particularly) was first shown and the subsequent isolation of these isotopes has given us heavy water. One of the remarkable effects of these low temperatures is that the electrical resistances of the common metals become vanishingly small.—*D.H.K.*

MILK

MILK will not boil over if a little glycerine is rubbed around the rim of the saucepan.

Wood Withstands Terrific Fire

IN a spectacular demonstration staged before officials and members of The American Building Officials Conference, a small frame building of chemically treated wood withstood in an amazing manner, according to Phillips A. Hayward, Chief of the Forest Products Division of the Department of Commerce, a most severe fire test. Tests were conducted at the plant of the Protexol Corporation, manufacturers of the chemicals with which the wood was fire-proofed.

The small building, approximating 10 feet by 12 feet in size, was of ordinary frame construction with a wood shingle roof. One outside wall was also shingled, the other three being sheathed only. All wood, including sash and doors, had been chemically treated, though the slab door had been treated some 30 years previously and had served in a now dismantled New York Hotel.

A large flat steel tray of ten inch depth placed inside the building on the ground was first filled with cotton waste. A tank truck then pumped over this waste a layer of highly inflammable liquid. The roof and outside walls of the building were likewise sprayed with the oil and ignited.

As soon as the inflammable liquid had been burned off the roof and sides of the structure, the flames quickly died down. It was then necessary to open the front door and throw in a flame to start the interior fire.

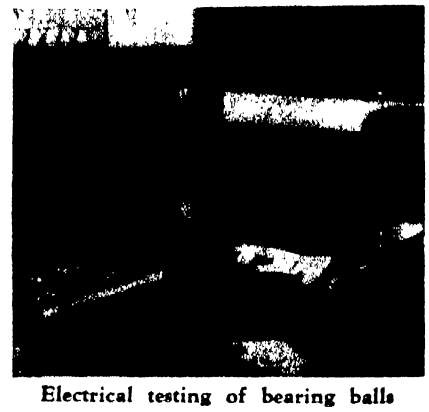
The raging inferno on the inside of the structure was permitted to burn for 40 minutes at a temperature exceeding 1800 degrees. By the end of 20 minutes the continued intense heat inside the structure had eaten through the end-wall peaks and the roof. The windows had of course gone out earlier. Not an ember was thrown and not a piece of wood went down flaming.

While chemists and wood experts have long known that wood and shingles could be chemically treated against fire, this is believed to be the most spectacular demonstration of the fact ever held.

Uniform Bearing Balls

ADDED uniformity in ball bearing manufacture has recently been made possible by a unique electrical testing unit which reveals internal defects and gives an indication of the micro-structure of the steel without injury to the surface of the ball itself. The equipment is shown in our photograph in operation at the plant of The Fafnir Bearing Company, for whom it was developed.

Balls to be tested are simply rotated on two small electrical contacts in the V-shaped



Electrical testing of bearing balls

notch in front of the operator, and a light beam moving over a ground-glass scale reveals whether or not they come within previously determined standards.

A balance of inductances between three known values and the ball to be tested, similar in principle to the balance of resistances obtained with a Wheatstone bridge, provides the basis of the test. Since the balls have been previously checked for size to within limits of .00005 to .0001 of an inch, settings are made on the basis of constant mass for each size of ball.

Experiments have shown that internal flaws, soft centers, excessive decarburization, and other variations in micro-structure all result in definite changes in the readings obtained. Since hardness also depends upon micro-structure, the measurement gives an indirect check on this factor as well. Correlation of the results obtained with metallographic examination, hardness tests, and the like provides standards for production tests. At present, all balls of one-inch diameter and larger, where variations due to heat treatment are more likely to occur, are tested on this equipment. Smaller sizes, down to ½ inch, may also be tested as a check on other inspection methods.

Shot Poison Ducks

WILD ducks often escape hunters' gunfire only to be poisoned fatally by lead shot which they eat in dabbling for food in marshy areas. Waterfowl losses from lead poisoning are common, and many ducks die from eating only four or five lead pellets.

The slow, toxic action of the lead first causes ducks to lose their power of flight,

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Taxiing down to the end of the runway, the pilot revs up each Wasp engine. The co-pilot radios to the signal tower, "O. K. Newark". The dispatcher flashes back "Go Ahead". The pilot gives full throttle. The Hamilton Standard Constant Speed Propellers bite into the air at 2250 r.p.m. And in a flash you are soaring on your three-mile-a-minute trip... as gracefully as any bird.

Home Craftsmanship

By Emanuele Stieri

Between the covers of this 346-page book will be found instructions for handling all kinds of tools that are ordinarily used in the home workshop. Hand tools and motor-driven tools alike are given careful consideration and the reader is told exactly how to obtain the best results with them. The first chapter, concerned solely with wood, will be of inestimable value to the man who likes to build his own furniture or to make repairs around the house. Included in the book are various projects to be undertaken. Thoroughly illustrated with clear line drawings and furnished with a complete index. The bibliography refers the reader to other books on the same subject.—$2.70 postpaid.

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and then their ability to swim or walk. In this helpless condition, even should they survive the ravages of the poison, the birds are likely to become victims of the elements or of predators. The Bureau of Biological Survey called attention to this waterfowl menace in 1919 and pointed out the hopelessness of any remedial measures.

"All that can be done," said the Bureau then, "is to call attention to the prevalence of lead poisoning and to describe the cause and symptoms, so that persons finding affected birds may understand."

But the outlook for preventing lead poisoning of waterfowl is somewhat brighter now. By mixing lead and magnesium, scientists of the University of Minnesota and of the Biological Survey have developed an alloy that disintegrates in water, or, if it is eaten by waterfowl, breaks up rapidly in the gizzard and passes through the intestinal tract before a fatal dose of lead can be absorbed by the bird's body. Ordinary lead shot when eaten by waterfowl are trapped in the gizzard and gradually are ground away. This finely divided lead absorbed by the duck's body as it passes through the intestine produces the poisoning. When the new alloy has been developed to the point where its use by shot manufacturers will be practicable, the scientists believe the dangers of lead poisoning will be greatly decreased.

POWER

MUSCLE power of man and animals used in all of man's activities totals 110 billion horsepower per year, it is estimated.

Energetic Jets

FEW materials have ever appeared so unpromising from a utilitarian standpoint as the recently discovered element deuterium, better known as heavy hydrogen. So much like ordinary hydrogen that refined experiments are required to show any difference, and costing even now 13,000 dollars a pound (to be compared with nine cents a pound for hydrogen), it seemed destined to remain a laboratory curiosity, yet an important use has been developed for it.

It has been found possible to produce jets of deuterium gas of such high velocity, reports the *Industrial Bulletin* of Arthur D. Little, Inc., that the energy available due to speed alone in one pound of the gas is equal to that obtainable from the combustion of 2500 tons of coal. The apparatus for producing the jets resembles a short-wave radio transmitter operating between the poles of a powerful electromagnet. When the jets impinge on various substances, profound changes occur and artificially radioactive bodies are produced. In particular, samples of common salt have been so far converted as to have a radioactivity half as intense as that of pure radium, and to give off more penetrating gamma rays (short X rays) than any naturally occurring radioactive substance. The great difference between the radioactive salt and radium is that the activity of the salt decays rapidly and becomes unappreciable after a few weeks, while that of radium continues practically undiminished for centuries. When radium

Air Conditioning

By J. A. Moyer and R. U. Fittz

HERE for the first time in one volume is a complete treatise. The first half of the book covers theoretical fundamentals and discusses such phases of air conditioning as air filtration, refrigeration, humidity control, and so on. The second half gives a thorough study of design requirements, including such features as examples of typical air conditioning designs with the necessary calculations for theaters, restaurants, food factories, textile mills, and so forth, also giving attention to recent advances in household, office building, railroad train, and theater applications.—$4.20 postpaid.

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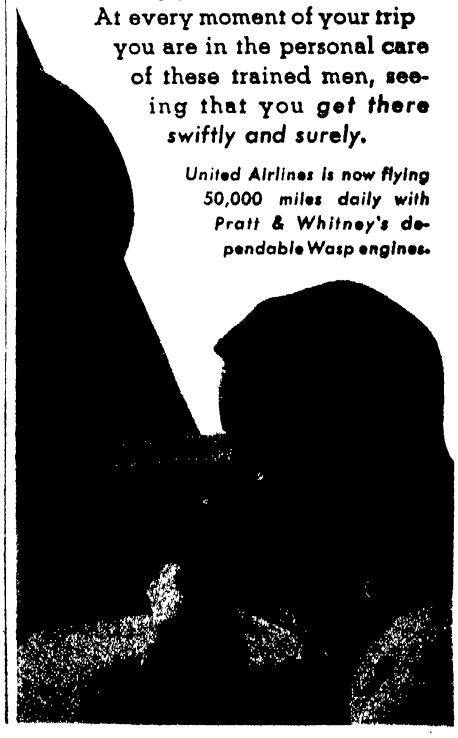

THE MECHANISTIC AUTONOMY OF NATURE
with 1935 and 1936 supplements on
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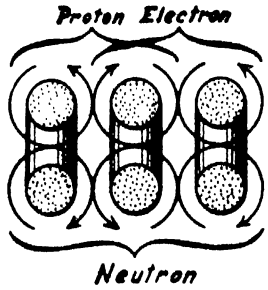

Official science, finding itself unable to produce any satisfactory picture or diagram of the atom under its erroneous nuclear theory, is now trying to tell the public that this quagmire of indeterminism, i. e. "the new order of things," is really a commendable step in advance. The author, however, prefers diagrammatic illustrations, and it will be seen that under the new vortex system the atom *can* be represented diagrammatically.

In the 1936 supplement there is presented for the first time QUANTITATIVE proof of the new vortex theory.

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decays it leaves a residue of radioactive substances, but radioactive salt decays to common salt with a little harmless magnesium chloride.

These properties of radioactive salt lead to the possibility of an important medical application. It is very dangerous to introduce radium compounds into the blood for relief of suffering, as there is no good way of getting rid of radium afterward, and prolonged exposure to radioactivity is dangerous. By this new development, however, it may prove possible to give radioactive salt by mouth or injection and obtain the beneficial effects of radium without the dangers.

"Liquid" Coal

To amplify the supply of liquid fuel required for oil burning furnaces and even for Diesel engines, large quantities of coal in an extremely fine state of subdivision are incorporated into fuel oil used in Great Britain. The method consists of grinding the coal to extreme fineness in the oil and adding a material which will prevent it from settling out. Many substances have been used to hold the coal in suspension but the most common one is a lime-rosin soap dissolved in the oil. By using such mixtures made with petroleum or coal tar oils, a substantial saving in the quantity of imported oil required for fuel is realized.—*D. H. K.*

Glass Fish Line

Zane Grey, and all those other dwellers of the upper-crust of Famous Fishing Feats, will please take their hats off to a 10-year-old boy. He has just accomplished one of those Ripley rarities—the landing of a fish with a line made of glass! He is Bob Crandall, of Ashaway, Rhode Island, son of J. T. Crandall, well known Eastern sportsman and veteran manufacturer of fish lines.

The youngster's achievement came as the result of the first actual test of a line made of fibrous glass, which has fascinating possibilities in the textile field as a result of the recent discovery of a revolutionary process to produce glass in fibrous form.

Bob's father took him to Thompson's Camps at Naples, Maine, for the test and the thrilled youngster landed a three-pound salmon in Sebago Lake, at the mouth of the Songo River, giving him the distinction of being the first person in the world ever to catch a fish with line made of pure glass thread. Bob caught his fish trolling a Black Ghost Fly.

Flux for Aluminum Solder

Of interest to solder and flux users is the new flux developed by the Alumaweld Company of America. This new flux, used in conjunction with a special, high strength solder, does a job heretofore considered impossible.

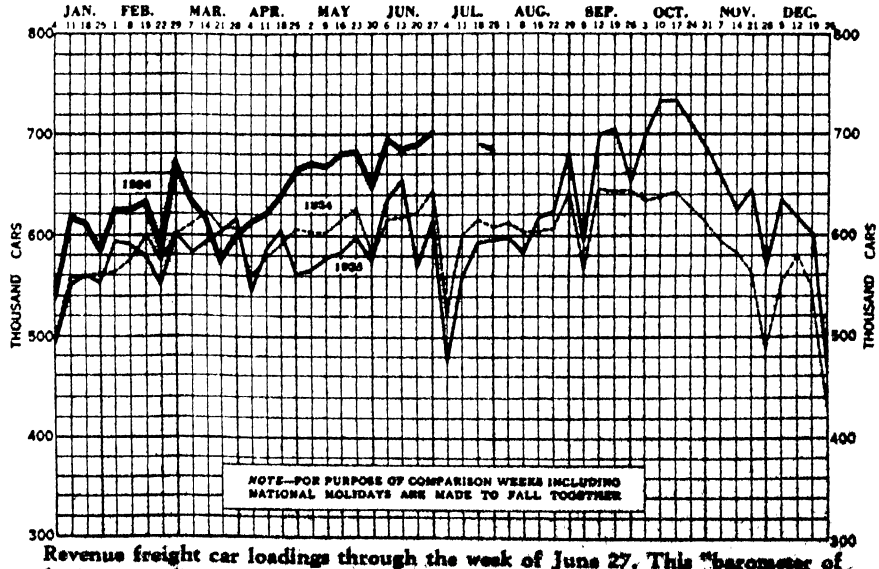
With Alumaweld flux it is now possible to make high-strength, permanent repairs on joints of any metals. It makes soldering easy because both solder and flux are applied with an ordinary soldering iron or blow torch. The soldering job is done at a low temperature but has the advantage of requiring high temperatures to melt it a second time. It works equally well on aluminum, stainless steel, die-cast pot metals, cast iron, copper, brass, and so on, which makes it easy to join any two different metals if desired. Alumaweld flux works with any type of solder.

Alumaweld solder has a tensile strength of 12,000 pounds, which is ten times that of ordinary solder. The finished joint can be worked or machined and takes a polish over which chromium or any other plating can be applied.

No Bedbugs on Swallows or Bats

Swallows and bats are often killed because they are thought to spread bedbugs. This is a mistake, says W. L. McAtee, of the Bureau of Biological Survey. Both swallows and bats are sometimes attacked by insects that do in fact resemble the despised and detested bedbug, but these insects are definite and distinct. One variety preys on swallows and another on bats, but neither attacks men nor has the same habits of life as the bedbug.

Swallows as a group are good friends of farmers. They are insect hunters, and work from daylight to dark gathering food for themselves and their young. In the course of a season each swallow accounts



Revenue freight car loadings through the week of June 27. This "barometer of business conditions" continues to show very marked improvement over last year.

for a quantity of insects that would otherwise make trouble in fields, gardens, and orchards.

Swallows are to be encouraged as working partners of the farmer and, as beneficial birds, are protected by state and federal laws.

Value from Farm Waste

HULLS removed from oats in making them useful for food were formerly a waste product burned under boilers but now as the raw material for the manufacture of furfural they have become industrially important in the refining of petroleum lubricating oils and in purifying rosin. The success story of furfural began shortly after the end of the World War when it was still a rare chemical laboriously produced by the ounce principally as a curiosity. Investigation of its value was undertaken in the belief that if use for it could be found the production of furfural from farm wastes would assist in solving the problem of disposing profitably of these by-products of agriculture.

Furfural was found to be valuable to the synthetic chemist in making a number of important compounds and resins but its peculiar value as a solvent has become more important than any of its other applications. In refining petroleum lubricating oils, the problem is to separate undesired materials from the oily part of the lubricant. Furfural was found to have the ability to dissolve the unwanted impurities in the lubricating oil and now is used in huge quantities for supplying better oils for industry.

In the refining of rosin, it was found that furfural would dissolve the greater part of the colored compounds which lowered the grade of rosin and would leave the clear rosin in solution in gasoline. This application has added importantly to the value produced by our naval stores industry. Thus the waste of the rolled oats industry has not only been profitably utilized but at the same time the material produced from it has increased the value of products of other industries.—*D. H. K.*

Are You an Alpha Omega?

YOU—anybody—can be a member of Alpha Omega, an honor society not yet founded, but proposed by President Max Mason of the Rockefeller Foundation before the recent semi-centennial celebration of the scientists' particular society, Sigma Xi. You do not need to be devoted to a life of science, as are the members of Sigma Xi. All that is required of the Alpha Omega "pledge," according to *Science Service*, is that he (or she) shall be dedicated to the scientific way of living.

That means that you will have to give up your pet superstitions, your carefully cherished predilections, your wavering but still stubborn belief in shadowy borderline quasi-sciences—until cold, hard, bomb-proof factual demonstration can be produced in their support. The password of Alpha Omega, Dr. Mason proposed, shall be "How do you know it?" and the answer, "What of it?" It will be distinctly a fraternity of the hard-boiled.

Such an attitude of scientific skepticism is needed especially in these days to probe and test the ground where structures of mass action are to be built, Dr. Mason intimated.

"Our civilization can advance as the art of living is enriched by the application of knowledge won through the sciences," he said. "But scientific and technical knowledge can be used to retard and even to destroy the things most valuable in our lives, if their use be distorted by prejudice, passion, or individual and group selfishness. The safeguard is to be found in proper emotional education, both formal and informal, for the attainment of self-control, and the acquirement of the objective attitude."

The Alpha Omegas are not universally popular, Dr. Mason warned, for they take an aggressive attitude to some of the foibles of their friends. "They do this because they believe that little things add together to make large things, and that mental attitudes are contagious. They continually see small and apparently harmless examples of belief and action that remind them of the burning of witches, of lynchings, of cruel intolerance, of the K.K.K., of the Black Legion, of mass murder in the name of patriotism. And so they do not keep their passwords secret—they use them every day."

Greek Shorthand

"STENOGS," wrinkling their pretty foreheads over notes that have "got cold" since the boss dictated them yesterday, just don't know how tough a transcription job really can be.

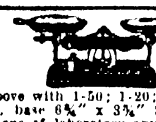
How would you like to try to decipher a shorthand notebook that somebody else wrote about 2000 years ago—in Greek?

That is the job which scientists of the British Museum have set for themselves. A chance to decipher ancient Greek shorthand now appears possible, according to *Science Service*, through the discovery, in the archives of the Museum, of a papyrus manuscript bearing many shorthand signs and in parallel columns the equivalent words in ordinary Greek characters. If you can read Greek really fluently, you might be able to puzzle out some of the stenographic notes.

This ancient shorthand is made up of about the same kinds of strokes that one finds in present-day Gregg, but there are surrounding flocks of "ticks" that are rather reminiscent of Pitman. The important "key" specimen in the British Museum appears to have been written by an expert, for the characters are smoothly and beautifully formed.

Considerable quantities of shorthand manuscript have survived from ancient Greek times, but until now nobody has been able to read them. The British Museum specimen is expected to unlock this stenographic literature, as the famous Rosetta Stone, found in Egypt over a century ago, unlocked the until-then mysterious hieroglyphic writing of the old Nilotic obelisks and temples.

Greeks of early Christian times, as well as of the classic days, had their shorthand-writing secretaries—who, incidentally, appear always to have been young men. The famous Church Father, Origen, is said to have kept seven stenographers busy with his rapid-fire dictation. Their notes were read by other scribes—frequently young women—who transcribed them in Greek



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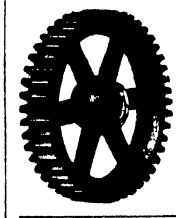

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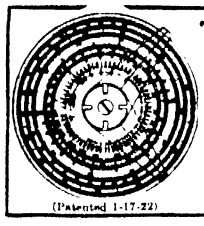

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longhand. Origen would doubtless have rejoiced, had he been able to get hold of typewriters—for he was a quantity-production author.

Shorthand appears to have been a required subject in some Greek school curricula. There is extant the parting warning of a Greek schoolmaster, just before vacation: "Now boys, don't forget everything I've taught you, during the holidays. When you come back next fall, if you don't remember both your arithmetic and your shorthand, I'll certainly make my cane dance on your backsides!"

Art in Nickel Silver

WHAT is practically a lost art is preserved by manufacturers of buttons for the dress uniforms of officers in a number of British Army regiments. These buttons, which are made of nickel silver, are hand-worked with designs cut out with fine jewelers' saws. The filagrees and designs are said to be comparable with those worked on precious metals. Some of the saw blades are so fine that they are practically invisible.

Baby Oil

FOR centuries, it has been a custom to anoint very young babies with oil, in lieu of water-washing. This all-over oiling procedure is usually followed for only a few weeks, but oiling following a soap-and-water washing may continue for a long time. Finally, a little oil is applied locally just to inflamed areas. Normally, the oil used has been the olive oil of southern Europe, for which cotton-seed oil and corn oil became widely substituted in this country. Recently there has appeared a strong trend toward specially-prepared oils for this purpose, with properties other than mere oiliness, says the *Industrial Bulletin* of Arthur D. Little, Inc.

The modern baby oil, besides being blended from several kinds of oils to secure the right spreading and coating properties, contains preservatives which keep it from becoming rancid and hence irritating; what is more important, it is made antiseptic toward the types of bacteria found on the skin. In addition, it is pleasantly perfumed.

The earlier attempts at surface antisepsis were made by rubbing mercury compounds on the skin, with or without oiling, a drastic procedure not entirely free from chance of irritation and of poisoning, and only partially effective at best in preventing or curing skin diseases. Antiseptic oils avoid the use of mercury, using instead the newer synthetic germicides. The effectiveness of antiseptic oil has been so demonstrable that it has been adopted by a number of maternity and babies' hospitals. Indeed, some superintendents have become so enthusiastic over its record in the prevention of impetigo and other highly contagious skin diseases that they have made its use a feature of their treatment and recommended it for continuation in the home, often up to the age of six months or more.

Several manufacturers have watched with wonder and chagrin as the market for packaged talcum powder has shrunk with rapidity, while baby oil has become an article of commerce with its volume already reaching sizeable proportions.

More Profit in Woodland If Only Big Trees Are Cut

THERE is a great deal more profit in lumber from farm woodlands when only the large, mature trees are cut and the small trees left to grow into another crop. The United States Forest Service has found that maple trees less than 12 to 14 inches in diameter actually do not pay their way through a band sawmill.

There is about 19 times as much lumber in a tree 26 inches in diameter as in a nine-inch tree. But since the lumber in the larger tree is worth about twice as much per foot, the total value is approximately 36 times as great.

Selective cutting removes the greatest value with the least volume. It leaves small trees as a windbreak and allows them to grow faster because they no longer need to compete with big trees for moisture, sunlight, and space to spread their crowns.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

A New and Fascinating Machine. Catalog description of a machine for cutting and polishing gem stones, also containing useful data for those who are interested in amateur gem cutting as a hobby. *Write for Bulletin 936A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Soil, the Nation's Basic Heritage tells the story of the restoration of natural water control through soil conservation and improvement, with particular reference to the work being done in the Tennessee Valley. *Tennessee Valley Authority, Washington, D. C.—Gratis.*

The Western Range. A report to the Secretary of Agriculture, on the original and present condition of the range resource, factors which have led to the present condition, and the social and economic importance of the range and its conservation. *Government Printing Office, Washington, D. C.—Gratis.*

Diesel, the Modern Power, describes in simple and non-technical language the development of the Diesel engine from the beginning to its present form. Beautifully illustrated with drawings and photographs, it tells the whole story and touches upon the future possibilities. *Technical Data Department, Research Laboratories Section, General Motors Corporation, Detroit, Michigan.—Gratis.*

Perspective and Optical Illusions of Depth, by Theodore M. Edison, deals with gages of depth and includes several striking optical illusions. A technical chap-

ter is devoted to the production of correct perspective and to the use of mechanical, optical, and photographic perspective drawing aids. *Request Calibron Notebook No. 3, Calibron Products, Inc., West Orange, New Jersey.—Single copies 50 cents; additional copies (in same package) 30 cents each.*

PROGRESS IN AIR CONDITIONING IN THE LAST QUARTER CENTURY, by Willis H. Carrier, reviews developments in this comparatively new industry and illustrates much of the equipment used in large installations. *Write for Bulletin 936B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

MANUAL ON PRESERVATIVE TREATMENT OF WOOD BY PRESSURE brings this subject completely up-to-date and outlines the characteristics of both woods and preservatives as they affect treatment. The book contains 50 working charts and tables. *Request Department of Agriculture Miscellaneous Publication No. 224, Superintendent of Documents, Government Printing Office, Washington, D. C.—15 cents (coin).*

THE NEW AND REVOLUTIONARY THINGS BEING DONE IN RAYON is a 16-page pamphlet dealing with all the phases of rayon manufacturing and use. *Write for Bulletin 936C to Scientific American, 24 West 40th Street, New York City.—3 cents.*

THE NEW WAR ON ACCIDENTS deals in a concise manner with the problem of traffic congestion. It answers the all-important question: "What can I do about it?" The answer should be heeded by everyone. *National Safety Council, 20 North Wacker Drive, Chicago, Illinois.—Gratis.*

THE NATIONAL PHYSICAL LABORATORY, REPORT FOR THE YEAR 1935. A 249-page account of the investigations in physics, electricity, radio, metrology, engineering metallurgy, and aerodynamics at Britain's "Bureau of Standards." *His Majesty's Stationery Office, Adastral House, Kingsway, London, W.C. 2, England.—12 shillings, net.*

FINE WIRES is a 14-page pamphlet describing various forms of resistance wires, metallic ribbons, and thin foils for electrical purposes. *Write for Bulletin 936D to Scientific American, 24 West 40th Street, New York City.—3 cents.*

SOIL SURVEYS FOR HIGHWAYS, Engineering Experiment Station, Circular No. 33. This 36-page booklet gives a brief summary of highway construction and a comprehensive review of present day methods. *Engineering Experiment Station, The Ohio State University, Columbus, Ohio.—Gratis.*

DATA CONCERNING PLATINUM describes metals in the platinum family together with their uses in industry. It also illustrates many of the different standard products made of these metals. A series of tables gives pertinent facts. *Write for Bulletin 936F to Scientific American, 24 West 40th Street, New York City.—3 cents.*

MODERNIZING THE KANSAS HOME, by H. E. Wichers, tells the story, mainly in pictures and short text, of how various types of homes in Kansas have been modernized. The remarks, of course, would pertain as well to homes in other sections of the country. An excellent bibliography is included. Bulletin No. 32, *Engineering Experiment Station, Kansas State College, Manhattan, Kansas.—Gratis.*

ADDITIONAL INFORMATION ON THE FOLSOM COMPLEX, by Frank H. Roberts, Jr. Report on the second season's investigations of the Lindenmaier site in northern Colorado, where evidences, 12,000 to 13,000 years old, of Folsom man's handiwork were found. *The Smithsonian Institution, Washington, D. C.—30 cents.*

LOWER-COST MANUFACTURING BY SHIELDED ARC WELDING shows some of the cost-cutting possibilities of this particular type of welding. *Write for Bulletin 936G to Scientific American, 24 West 40th Street, New York City.—3 cents.*

HOME FIRE HAZARDS is essentially a handbook of warning, putting forth as it does many of the reasons for fire in the home. *Research Department, American Fire Insurance and Indemnity Group, 80 Maiden Lane, New York City.—Gratis.*

THE FUTURE OF RADIO is a reprint of a statement by David Sarnoff before the Federal Communications Commission. It outlines the public interest in radio, the convenience value of radio communication, and, particularly, the developments which may be expected in television and other uses of the ultra high frequencies in the near future. *Radio Corporation of America, 30 Rockefeller Plaza, New York City.—Gratis.*

POINT DISCHARGE IN THE ELECTRIC FIELD OF THE EARTH. By F. J. W. Whiple and F. J. Scrase. An analysis of continuous records of the discharge current between the earth and the atmosphere. *His Majesty's Stationery Office, Adastral House, Kingsway, London, W.C. 2, England.—One shilling sixpence, net.*

RHODANIZE describes in a non-technical manner a process for protecting the surface of any silver object from atmospheric and other causes of tarnish. *Write for Bulletin 936E to Scientific American, 24 West 40th Street, New York City.—3 cents.*

PAINT AND VARNISH by Joseph H. Koffolt and James R. Withrow. This 20-page pamphlet sets out to prove that paint does not cost—it pays. It tells briefly and concisely of the protective value of paint and varnish and of the selection and use of these materials. It also deals with the application of paint and varnish—how and when they should be used. Circular No. 32, *Engineering Experiment Station, Ohio State University, Columbus, Ohio.—Gratis.*

THE DEPENDENCE OF TERRESTRIAL TEMPERATURES ON THE VARIATIONS OF THE SUN'S RADIATION. By G. C. Abbot, Secretary, Smithsonian Institution. The results of five more years of solar study with regard to long-range weather forecasting, giving affirmative answer to the question "Does the variation of the sun's radiation sensibly affect the course of temperature in terrestrial weather?" *The Smithsonian Institution, Washington, D. C.—10 cents.*

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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THE aerial photograph reproduced on this month's cover shows the traffic divider, part of the Triborough Bridge, located on Randall's Island, New York. By means of the various ramps, traffic from the three connected boroughs is routed safely without the use of grade crossings, and tolls are collected with a minimum of delay. Other photographs of the bridge and pertinent details are given on page 206.

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of October, 1886)

WELDING—"According to the *Electrical World*, Professor Elihu Thomson, of the Thomson-Houston Electric Company, has invented a method by which metal wires can be welded together without the application of external heat, but simply by passing strong currents of electricity between the joint of the two pieces to be welded."

UNDERGROUND LINES—"Nearly a year and a half have passed since the subway commissioners were appointed, under a special act of the Legislature, to supervise the burying of the telegraph lines in New York City. To do this work intelligently, a special study of the subject was required, together with a comparison of the different methods proposed by inventors. As the telegraph companies had done nothing to further the objects of the commission, a subway company was formed. This company, receiving its franchise from the commissioners, is now engaged in laying the conduit."

MECHANIZATION—"The whole tendency of modern industrial progress is in the direction of abolishing manual labor in manufactures, and substituting for it machinery, which is being constantly improved, and which in the not distant future may be expected to reach still higher stages of perfection."

MACHINE GUNS—"The friends of H. S. Maxim will be glad to know of his success in London with an automatic machine gun of his invention. The *Mechanical World*, of London, describes Mr. Maxim's experimental works. . . . The guns to be seen here are extremely interesting from a mechanical point of view, as well as the process of manufacture and the tools employed. The Maxim machine gun is bound to play a very important part in future military operations, and will probably greatly alter the conditions of machine gun warfare."

PATENT OFFICE—"The receipts of the Patent Office for the year 1885 exceeded the expenditures over $163,710, while the balance on hand January 1, 1886, was $2,945,405.58; and yet the Commissioner of Patents cannot get Congress to appropriate a sufficient sum out of the surplus patent fund to enable him to employ a sufficient examining force to keep up the work of the office."

MORTAR—"Some details have come to hand concerning the new Fere gun from which the French expect so much. It is, we learn, a mortar of unusual size, throwing twelve shells with more than ordinary precision for its type. The shells are a trifle over three feet in length, and contain an explosive said to possess extraordinary power of destruction."

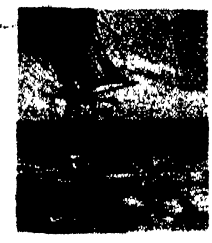
FAST STEAMERS—"A new company has been formed to run steamers between Liverpool and the Isle of Man. . . . The company has arranged a conditional contract for two first-class screw steamers, handsomely fitted and furnished, having triple expansion engines of about 1,500 horse power, and to be fitted with bilge keels, which prevent rolling to a great extent. . . ." They are "to steam at 17 to 18 miles an hour."

ALUMINUM TIN—"The applications of aluminum are now considerable, and M. Bourbouze, a French physicist, has added to their number by employing an alloy of the metal with tin. . . . The alloy he employs consists of 10 parts of tin and 100 parts of aluminum. . . . It can be soldered as easily as brass."

WOMEN SCIENTISTS—"An agreeable illustration of the capacity of the feminine mind to grapple with the abstractions of science was afforded in the recent annual meeting of the American Science Association, whose proceedings were illuminated by the personal participation of several lady members."

ELECTRIC BOAT—"On September 13 last the electric boat *Volta* crossed from Calais to Dover and back again under the propulsion of power stored in secondary batteries. The double trip was made with a single charge, which proved amply sufficient for the purpose."

BALLOON TRAVEL—"Among the means employed for traveling in a balloon over the sea, we consider as very important the use of a float for converting the balloon into a captive one, and the use of a cone anchor, permitting of the reception of water hoisted up from the ocean with a pail, since the sun at daybreak tends to cause the balloon to rise into the higher regions, and to make it lose, through expansion, a portion of the gas that it contains. With these several methods of anchoring one's self to the sea and taking in ballast, it is not impossible to undertake long balloon trips over the ocean."



GLASS RAILS—"Friedrich Siemens, of Dresden, has succeeded in casting glass in the same way as metal is cast, and obtaining an article corresponding to cast metal. This cast glass is hard, not dearer in production than cast iron, and has the advantage of transparency, so that all flaws can be detected before it is applied to practical use. . . . The hardness and resisting power of this cast glass are so great that experiments are being just now carried out at the Siemens glass foundry at Dresden with the purpose of ascertaining whether the material could be employed for rails on railways."

LONG DISTANCE—"While much is being accomplished in long distance telephony at various parts of the country, it has not yet reached a point as to efficiency which may be regarded as wholly satisfactory, nor has it yet proved itself formidable in competition with the telegraph. . . . In telephony 100 miles or thereabouts seem to be the paying limit at present, notwithstanding the fact that a line has successfully operated between New York and Chicago, a distance of nearly 1,000 miles, and several others have been experimented with, each giving more or less satisfaction according to conditions."

AND NOW FOR THE FUTURE

¶Latest Developments in Science's Battle With Crime, by Andrew R. Boone

¶Chemistry, Industry, and the Farmer, by Francis P. Garvan

¶The Albert Canal, in Belgium, Simplifies and Speeds Up Inland Transportation

¶Taking the Guesswork Out of Flying, by T. Lee, Jr.

¶How and When Man Discovered Pottery, by Jotham Johnson

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AND MY LUNCHEON'S ALL ARRANGED"

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A telephone extension upstairs, beside the bed, is a great convenience at small cost. Saves steps and time—insures privacy.

BELL TELEPHONE SYSTEM

THUNDER OF WHITE WATER AT BOULDER DAM

THIRTEEN feet higher than Niagara Falls, this man-made fall of roaring water at the canyon wall outlet on the Arizona side below Boulder Dam, is a truly remarkable, 180-foot-high spectacle. This photograph, made from Lookout Point on the Nevada side, is reproduced through the courtesy of the Bureau of Reclamation. The freight car being lowered by a permanent cableway to the Nevada powerhouse, hidden by the canyon's brink, affords a striking comparison. Incidentally, it is simpler to deliver supplies and equipment to the plants in this manner than to deliver them piecemeal by cableway.

Courtesy Chantier & Atellers de St. Nazaire Penhoet

As a modern giant, the *Normandie*, goes down the ways, the grease smokes under pressure of the fore poppet

Getting the Big Fellows OVERBOARD

As a Ship Goes Down the Ways, Spectators See A Spectacle but Know Not the Careful Preparations, the Dangers, the Suspense, and the Drama

By COMMANDER W. MACK ANGAS, (CEC) U. S. N.

OF the romance and drama of modern science and industry, much has been written and said. Dramatic moments occur beyond doubt in most fields of scientific and industrial endeavor, but they normally take place in the seclusion of an operating room, laboratory, or testing ground. The launching of a big ship is an exception to this general rule. When a great vessel is launched—in fact at the launching of any ship of noteworthy size—thousands of spectators glimpse one of industry's most stirring spectacles.

Though he views a remarkable spectacle, the average guest at a launching becomes so engrossed in the christening ceremony that he fails to appreciate the significance of much that is of real interest. Consider what the general spectator sees at a launching and then go behind the scenes and observe the less commonly understood features of the undertaking.

The day of an important launching is a busy one at a ship yard. Guests begin to arrive an hour or more before the scheduled time. Watchmen and yard police examine passes and invitations, direct automobiles to parking places, and see that the various guests reach the roped-off areas from which they are to watch the proceedings. The more privileged guests are grouped near the sponsor's platform at the bow of the ship which stands on the building ways with its stern toward the water. The ship is decorated with flags and the sponsor's platform, at the foot of the towering stem, is gay with bunting. There is a sound of hammering, the dull thud of wood mauls on oak blocking, as gangs of men remove shores and keel blocks and make final preparation for the release of the ship.

The crowd thickens, the sound of hammering stops and workmen crawl from under the ship and report to foremen that their assigned tasks have been completed and the ship is ready to go. Tugs and small craft move slowly and expectantly about the harbor. A patrol boat warns approaching craft to keep clear of the path which the new ship will take when released. The current, which has been running upstream, slackens as the turn of the tide approaches. On the platform at the bow an official of the ship yard warns the sponsor that a champagne bottle, especially when covered with a basket weave of ribbon, is not easily broken and explains the old nautical tradition of the bad luck that follows a ship which is not properly christened. Photographers' flash bulbs wink as last minute pictures are taken of the smiling sponsor, the champagne bottle in her right hand and a sheaf of roses in the crook of her left arm. All

noise of work around the ship has stopped and a band stationed near the bow is clearly heard playing popular airs. The photographers' activities stop. They reload their cameras for pictures of the actual launching. The band is quiet, and for several long minutes there is no sound and no movement except the slow drifting of the waiting tugs.

Suddenly a shrill whistle blast breaks the silence. There is an ominous creaking under the ship and slowly, almost imperceptibly, she starts toward the water. The sponsor smashes the wine bottle over the receding bow and those near her hear the words "I christen thee ———" The ship gathers speed and as the stern reaches the water, a pandemonium of whistle blasts breaks out from every tug and vessel within sight or hearing. Faster and faster moves the ship. The water is foaming along her sides now and the stern lifts as it becomes water borne. The grease on the two wood runways, down which the ship is rushing, smokes with the heat of the friction. A moment later the bow dips deeply as the cradle slides off the ends of the launching ways. The ship is afloat!

THE speed of the ship slackens as she moves out into the harbor and lines are heaved from her to the waiting tugs which are to tow her to the fitting-out pier where she will be completed. She moves slowly in toward this pier under the guidance of the tugs as the crowd of onlookers disperses.

As members of the sponsor's party stroll toward the luncheon which awaits the guests of honor, an admiral's wife is seen furtively dabbing at her eyes with her handkerchief.

"I always cry at a launching," she explains. "It makes me think of the time when my baby took her first step."

A few spectators find their way to the fitting-out pier to see the new ship brought alongside, but the rest have by now left the ship yard. All will say they have seen a ship launched, but the majority has seen little more than the christening ceremony. Few appreciated the tenseness of the responsible officials in those last few moments before the launching triggers were released.

No sane engineer would undertake the launching of a large vessel down greased inclined runways, or ways as they are called, were there not a huge store of empirical data which can be drawn upon to predetermine the behavior of the ship under different assumed conditions. The builders of the early paddle-wheel transatlantic liners in all probability would have been unable to get such giants as the *Normandie* or *Queen Mary* into the water even if they could have built them.

That the builders of our early steamships would have had difficulty in launching a ship the size of a modern liner was demonstrated in the middle of the last century when the eminent British engineer, I. K. Brunel, proposed and actually carried out the construction of a ship of such size. The *Great Eastern*, with her length of 692 feet and gross tonnage of 18,914, while far smaller than such giants as the *Bremen*, *Europa*, *Rex*, *Normandie* and *Queen Mary*, would be, nevertheless, a big ship today. Despite Brunel's undoubted genius, the problem of getting the *Great Eastern* overboard was too much for him. The huge hull, which he attempted to launch sidewise, stuck on the ways and was not floated until three months had elapsed and the original company, formed in 1851 to build and operate the ship, had gone into liquidation.

Nor was the *Great Eastern* the only ship to get into trouble when launched. Ships have stuck on the ways; ships have broken away prematurely from their restraining gear and crushed workmen engaged in making final preparations for their launching; others have gone down the ways so fast as to become altogether unmanageable and have crashed into piers on the opposite shore before being brought under control. At least one large merchant steamer capsized and sank immediately after leaving the ways. The British battleship *Albion*, when launched in 1898, set up such a wave that 200 spectators were swept into the Thames and 50 of them drowned.

The Duchess of York was sponsor for the *Albion*. One can imagine her feelings when some 36 years later, as Queen of England, she pressed the button which released the heaviest hull ever to be launched, saw it start toward the waiting Clyde, broke a bottle of Australian burgundy over the moving stem, and, instead of the traditional "I christen thee ———," said "I am happy to name this ship the *Queen Mary* and wish good luck to her and all who sail on her."

THE launch of the *Queen Mary* was a complete success. A hundred seconds after the ship was released she was afloat and under control. Her builders had predicted that she would travel 1194 feet before coming to rest. She actually traveled 1196. Long experience with the launching of large ships into the restricted waters of the Clyde enabled the *Queen Mary's* builders to get the huge hull afloat without accident. Similarly the experience of our own yards and the big ship yards of France, Germany, Italy, Ireland, and Japan have enabled them to carry out their recent launchings successfully. Experience, forethought, and skill may be said to have overcome the risks of launching. Meeting a known risk with skill and experience may overcome it, but can not eliminate it. The inherent features of the risk are still there. A brief consideration of the mechanics and mechanism of ship launching should enable one to grasp how such an innately risky undertaking is successfully accomplished.

A ship is not built on the launching ways, but on building ways. The launching ways are inserted under the hull a few weeks or days before the launching and the weight of the ship is transferred to them only a few hours before she goes overboard. The building ways usually consist of a heavy timber or concrete platform of about the length and width of the ship to be constructed. For the conventional endways launching, the ways are built at right angles to the shore and slope gently down from their inboard, or shore, end to the water's edge in a series of shallow steps. Each step extends

Courtesy Great Lakes Engineering Works

A ticklish job: side-launching of a Lake freighter

completely across the ways and if it is a foot in height the steps will be a little less than 24 feet apart, the slope of the building ways for a large ship usually being slightly more than one-half inch to the foot. As a general rule the larger and heavier the ship, the flatter the slope of the ways. Cranes for lifting material and equipment into place on the hull stand alongside the ways or travel over them on latticed girder runways supported by steel towers.

The keel of the ship is laid on a row of keel blocks which runs down the center of the building ways, each keel block consisting of several timbers resting one on another. The heights of the blocks are so adjusted as to give the keel a downward slope toward the water. The slope will be about the same as the slope of the ways—perhaps a little more, perhaps a little less—but for a large ship it will be a trifle more than one-half inch to the foot. As the ship grows under the hands of the builders, rows of timber shores are used to support the widening bottom. Later on, as the sides of the hull rise from the bottom frames, longer timber shores are used to support parts standing high above the ways and to brace the hull against rocking on the keel blocks. Finally the hull reaches a state of completion determined by the builders as proper for launching.

THE state of completion of the ship when she goes overboard may vary from a bare hull to a virtually completed ship. In fact, ships have been launched complete and ready to run. An extreme case occurred on the Great Lakes when a freighter was launched sidewise with steam up. She left the scene of the launching under her own power! But in the vast majority of cases a vessel, particularly a big vessel, is far from complete when she leaves the ways.

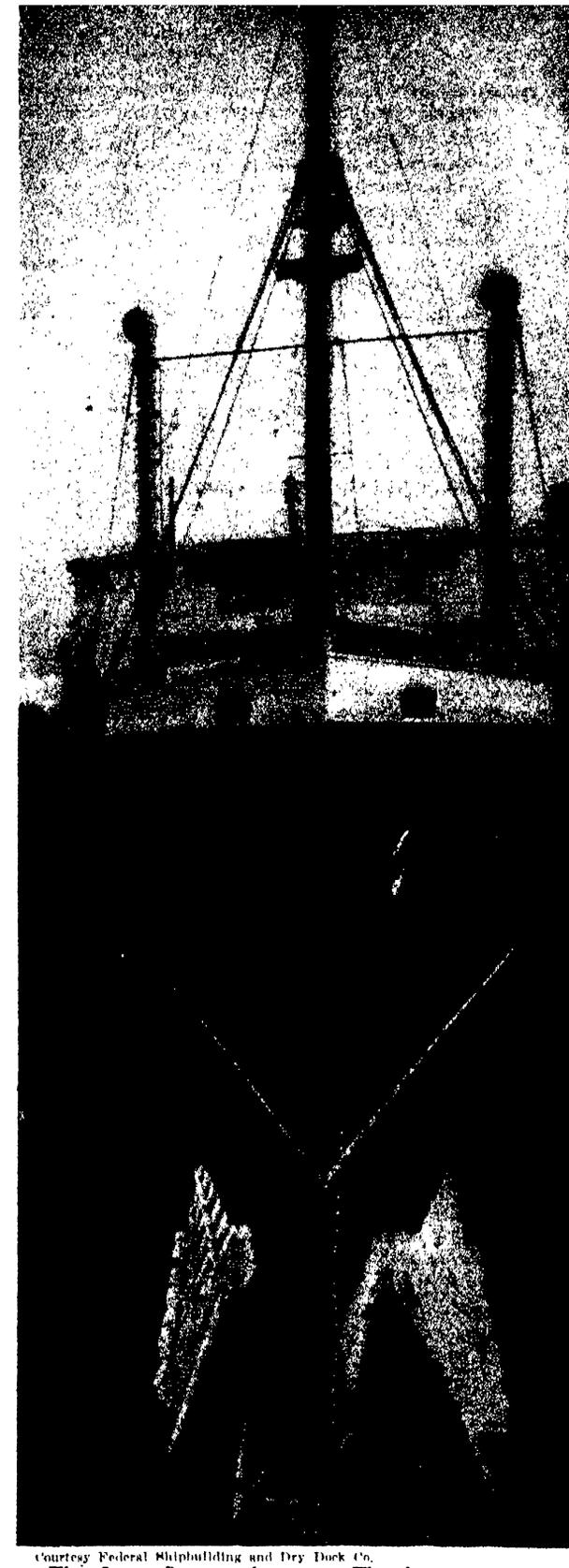
The state of completion at which the builders of a large ship elect to launch depends upon a number of factors. An important one is the relative ease of handling materials at the building ways and at the fitting-out pier. If the ways are equipped with heavy overhead cranes, the builders will often install boilers and machinery before launching, while at another yard these would have to await installation at the fitting-out pier where cranes of large capacity are invariably available.

The anticipated height of the tide is an important consideration when a launching date is to be selected. Tide tables are consulted and a date is usually chosen which will bring an exceptionally high tide at a suitable time of day. John Brown and Company, the builders of the *Queen Mary*, considered the tidal predictions for each day in the months of August and September, 1934, before finally selecting September 26th as the most suitable day. On this date it was estimated that even with adverse wind and weather conditions there would be eight feet, three inches of water over the way ends. With the favorable conditions that actually prevailed, the depth over the way ends was eleven feet, six inches. We had similar luck at the New York Navy Yard when the cruiser *New Orleans* was launched, the tide on the launching day being augmented by an east wind to such an extent that it threatened to flood the pits under the ways in which the launching triggers were located.

Other important related factors affecting the choice of a launching date are the weight of the ship at various stages of completion, the calculated strength of the hull, and the strength of the ways. Launching undoubtedly places on some parts of the hull the heaviest stresses that they will ever be called upon to bear. It is usual to add temporary internal bracing to enable the hull to withstand these stresses, especially if the vessel is to be launched at a fairly advanced state of completion and in consequence will be relatively heavy when launched. As an example of the differences which may occur between the launching weights of two vessels of about the same size when built under different conditions at different ship yards, it is only necessary to give the figures for the *Normandie* and *Queen Mary*. The ships are of about the same displacement or total weight. The *Normandie* weighed, with her cradle, 27,660 tons when she was launched, while the corresponding figure for the *Queen Mary* was 36,700 tons.

WHEN the hull is ready to go overboard the launching ways are installed under it. The ways consist of two main parts—the ground-ways or standing ways, and the sliding ways. The ground-ways, as their name implies, are the fixed runways down which the ship travels when launched. They are firmly supported by and attached to the building ways. The sliding ways travel with the ship when she is launched. They slide on the greased ground-ways and, together with the poppets and packing, which are about to be described, form the cradle which carries the ship down the ground-ways into the water.

The ground-ways are timber runways extending from the bow of the ship out into the water beyond the stern. They are of very heavy construction, being built of timbers not less than 12 inches square. Oak is often used for those parts of the ways which will be called upon to carry the heaviest loads. There are usually two ground-ways, each from six to ten feet in width, and they may be spaced from 25 to 30 feet apart center to center. The *Queen Mary* was launched from two ground-ways ten feet six inches wide and twenty-nine feet six



Courtesy Federal Shipbuilding and Dry Dock Co.

The *Santa Rosa* ready to go. The fore poppet, or forward part of the cradle, has been painted white

inches apart. The use of four ground-ways was considered for this exceptionally heavy vessel, but the idea was finally abandoned in favor of the conventional two. Four ways have been used successfully, however, notably in the case of the British super-dreadnaught *Nelson*.

The ground-ways take the general slope of the building ways, a little more than a half inch to the foot, and are securely supported by blocking which rests on the building ways. Each of the ground-ways has a ribband, something like a heavy wood curb, on its outer edge to guide the sliding ways. The upper surfaces of the ground-ways are finished smooth and then given a heavy coat of grease before the sliding ways are set on them. The ways are not merely greased —the grease is put on thick. When the airplane carrier *Saratoga* was launched at Camden, the ground-ways were given a three-quarter inch coat of stearine and an additional one-eighth inch of lighter grease was spread on top of that. The total amount of grease used for this launching exceeded 34 tons. The stearine is melted, poured onto the ways when still hot, and is ironed smooth with hot irons. Naturally it cannot be applied to the outer ends of the ways which are submerged at low tide. These are lubricated with soft soap deposited in closely spaced piles.

The sliding ways extend from the bow nearly to the stern. Their outboard end is usually in about the vicinity of the rudder of the ship. Somewhat shorter than the ground-ways, they are of similar materials and construction. They are usually built in sections of convenient length for handling, these sections being assembled and fastened together on the greased ground-ways. Before the sliding ways are put in place on the ground-ways, their lower surfaces are sometimes given a thin coat of stearine. Timbers and tie rods connect the two sliding ways and insure their acting together. Between the sliding ways and the hull of the ship is inserted packing consisting of heavy timber blocking. This packing conforms to the hull shape and, with the sliding ways, forms the cradle which carries the ship to the water. At the bow and stern, the packing is of unusually heavy construction and is fastened together very securely to withstand severe stresses, these extra heavy parts of the cradle being known as the fore poppet and the after poppet. Heavy steel latches or triggers prevent the cradle from sliding down the ground-ways prematurely. The release of these triggers, usually by pneumatic power, lets the cradle go.

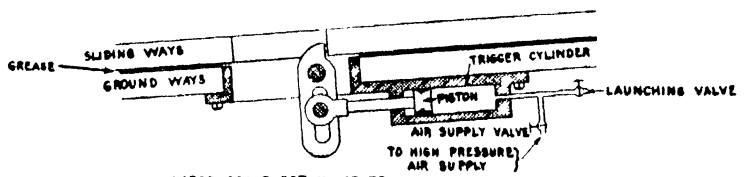
THE assembly of the ground-ways and cradle under the ship does not complete the preparations for launching. The cradle is under the hull, but the weight of the hull does not rest on it. The hull is still supported by the keel blocks and shores upon which it was built. The task of transferring the weight of the ship to the cradle and launching ways is accomplished immediately before the launching. The previous day it is usual to split out alternate keel blocks, this being rendered easy by the inclusion in each keel block assembly of a piece of soft wood which can be readily split and removed. The blocks thus removed are at once replaced by blocks capped with a metal container full of dry sand and fitted with a valve or shutter through which the sand may be allowed to escape. A block which rests on the sand is fitted tightly against the keel, and wedges, provided in the keel block assembly, are driven up tight to make the sand boxes carry load. When the sand boxes are all in place, the keel blocks hitherto left in place, are split out and removed. These are not replaced. A few hours before the launching, the packing between the sliding ways and the hull is tightened up by driving home wedges which were placed between the timbers of the sliding ways and the packing. This is done systematically until the packing is tight. The sand valves are then opened allowing the sand to run out of the boxes, thus relieving the keel blocks of their load. The keel blocks and shores are finally removed and the ship rests on the cradle and is ready to go.

She is ready to go, but will she start when the triggers are released? If she starts, will she go too fast and too far?

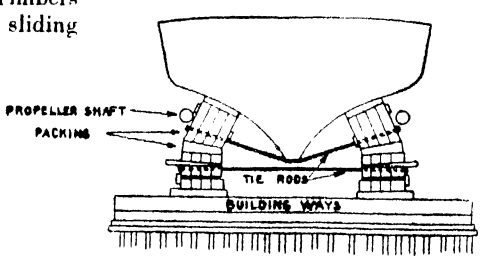
To guard against the contingency that the ship may not start, it is customary to mount powerful hydraulic jacks at the inboard ends of the sliding ways so they can push the sliding ways down the ground-ways, thus breaking the static friction and giving the cradle a start. I have seen jacks installed in this way many times, but it so happens that I've never seen them used. They are of great value, nevertheless, when a ship fails to start when released.

To prevent a ship going too fast down the ways, becoming unmanageable, and crashing into something at the opposite side of the river, a number of expedients are used, the elaborateness of these depending upon the degree to which the travel of the vessel must be restricted.

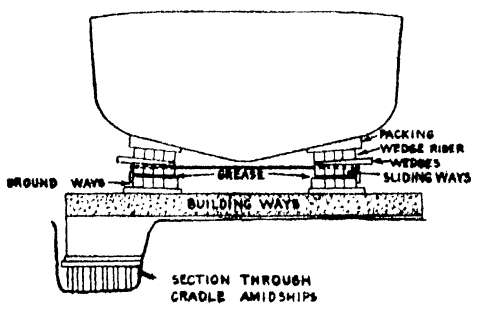
If the body of water into which a ship is to be launched is wide and deep, very little in the way of checking gear is necessary. The airplane carrier *Saratoga*



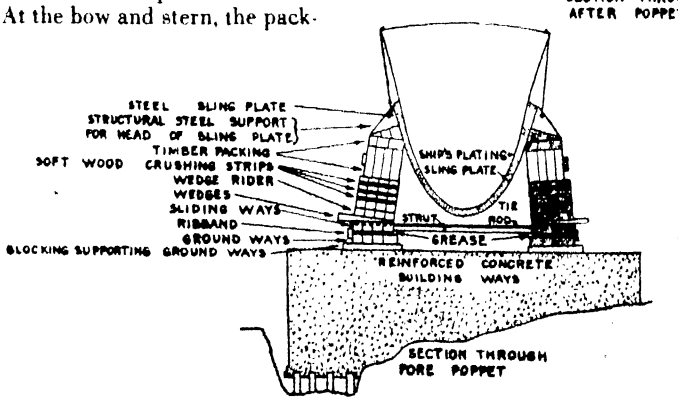
LARGE SCALE DETAIL OF TRIGGER



SECTION THROUGH AFTER POPPET

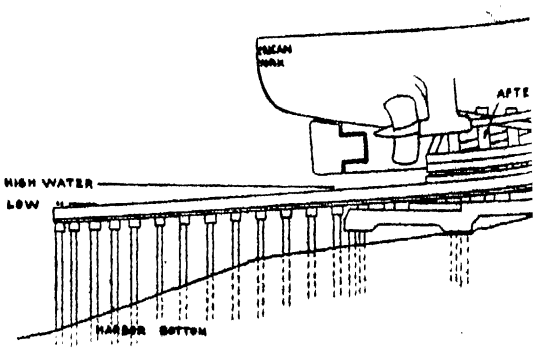


SECTION THROUGH CRADLE AMIDSHIPS



SECTION THROUGH FORE POPPET

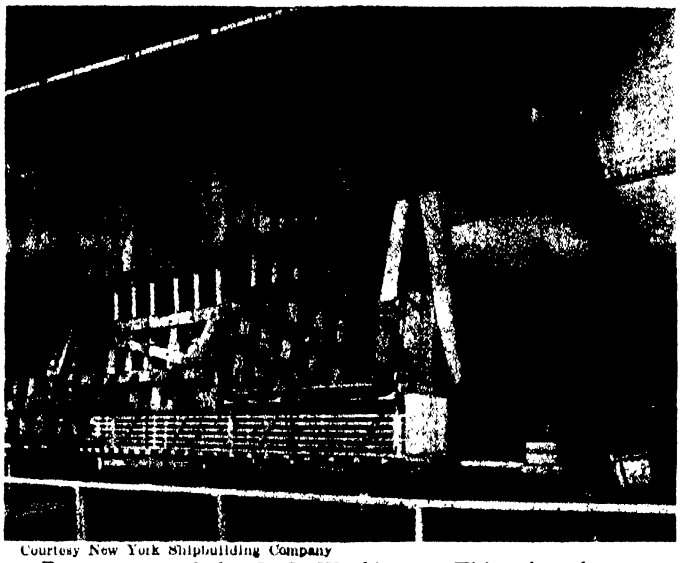
All drawings by the author



was launched under such conditions, the Delaware being a big river at Camden where the ship was built. A smaller vessel might have been allowed to run free at such a plant, but because of the *Saratoga's* great length and weight, it was necessary to make some provisions for checking her run. This was done by locking the propellers to prevent their turning and thus increasing their resistance to passage through the water, and by using anchors as drags to stop the ship after she was afloat. As the builders did not want to check the ship until she had left the ways, the propellers were left free to revolve during the actual launching and were locked with brakes installed on the shafts as soon as the cradle left the ways. Five anchors of 20,000 pounds weight each were dropped from the bow after the ship left the ways and slack lines were run from the stern to anchors previously planted in the river bed. The lines, or rather steel cables, to these anchors did not come taut until the ship was afloat. Actually the stern anchor lines broke at the shackles shortly after they came into play but, nevertheless, the ship was brought safely to rest after traveling about a thousand feet.

When a large vessel must be launched into closely restricted waters, much more elaborate checking gear is necessary. The American airplane carrier *Lexington*, and the Cunard-White Star liner *Queen Mary*, were both launched into narrow harbors, and it was imperative that they be brought to rest almost immediately after leaving the ways. This was done by arranging huge bundles of old chain on the ground alongside the ship and connecting these to the hull with steel cables so that they were dragged by the ship as she moved. The total weight of the chain drags used to check the *Queen Mary* was 2350 tons. The chain was arranged in bundles, each bundle weighing from 55 to 70 tons.

Other means of checking the run of a ship are sometimes used. A wood mask may be built over the propellers and the after end of the cradle to increase water resistance. When the battleship *California* was launched at the Mare Island Navy Yard, a system of hydraulic brakes was used. These acted on steel cables attached to the ship. The brakes worked well, but the cables broke and let the ship run further than she should have. So much for checking gear. Let us now return to a consideration of how the cradle carries the ship down the ground-ways into the water.



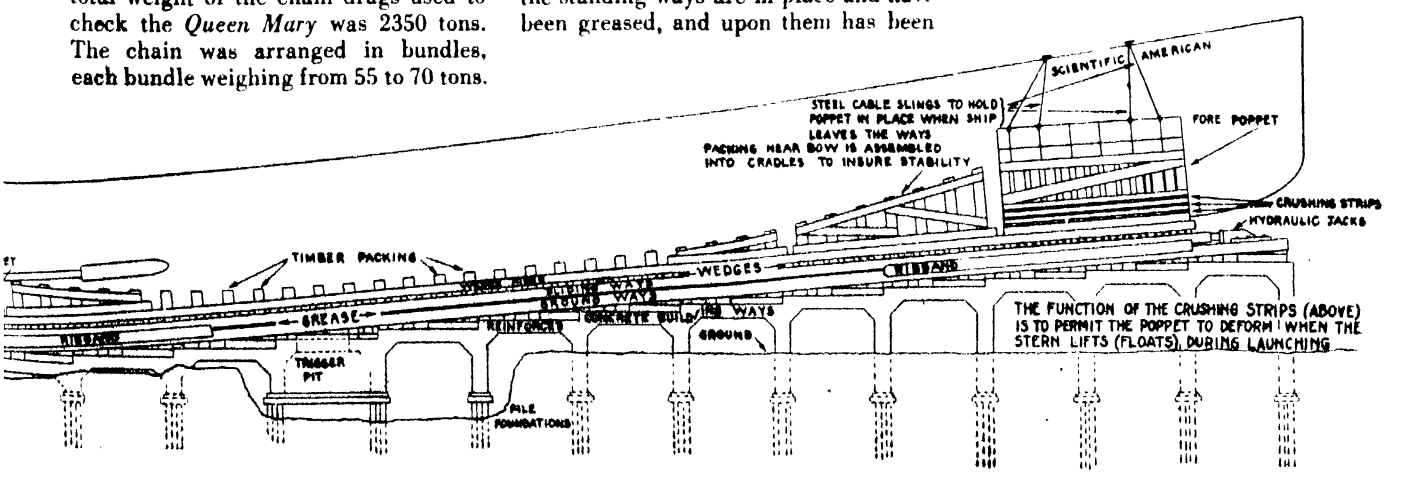
Courtesy New York Shipbuilding Company

Fore poppet of the S. S. *Washington*. This takes about a fourth of the weight of the vessel when the stern lifts

The forward and after ends of the cradle, or the fore poppet and after poppet, have been described as of specially heavy construction. The function of the poppets may be readily understood from consideration of what happens during the critical hundred seconds or so which elapse from the time the ship is released until she is safely afloat and under control. Let us imagine that a large ship is to be launched and the preliminaries have been accomplished. The hull has been inspected for overlooked openings, the standing ways are in place and have been greased, and upon them has been assembled the cradle which consists of the sliding ways, wedges, packing and the poppets. The wedges under the packing have been driven up tight, the keel block and shores have been removed, and the weight of the hull rests on the cradle. The huge steel latches called triggers fasten the sliding ways to the ground-ways. The weight of the hull strains at these as if eager to reach the water. A final inspection of the submerged ends of the standing ways has been made by divers to insure that no obstructions will hinder the smooth passage of the sliding ways over them.

As the hour of the launching approaches, observations of the strength of the current and height of tide are made. The tide must reach at least a predetermined minimum height to enable the ship to be launched safely, and there must be no strong cross current or cross wind to slew the ship off the ways.

With the release of the triggers, the cradle with the ship on it starts to move down the greased inclines of the ground-ways. The after poppet carries the weight of the overhanging stern, but otherwise the hull is supported for practically its entire length until the after poppet clears the ends of the ground-ways. By this time, the water is giving the stern some support, but not enough to float it. In consequence, the stern overhangs the ground-ways like a huge cantilever beam, the deck is subjected to tensile stresses and the pressure on the way ends rises to a maximum. This way-end pressure may amount to as much as 10 or 11 tons per square foot. Temporary shoring has been installed in the hull to resist the tendency of the way end pressure to crush in the bottom. As the ship slides farther into the water,



Diagrammatic drawing of ship on launching ways with keel blocks and shores removed—ship is ready to go

Courtesy New York Shipbuilding Company

When the liner clears the ways, the hanging anchors will be dropped to check her run

the deeper immersion of the stern increases its tendency to float, thus decreasing the way-end pressure and preventing the ship from tipping like a huge see-saw over the way ends as a fulcrum. Farther movement down the ways immerses the stern so deeply that it floats. When the stern floats, the ship is said to pivot. The stern is water borne and the entire ship is lifted off the ways, except the bow, which rests on the fore poppet.

About one-quarter of the total weight of the ship momentarily rests on the fore poppet and the resulting pressure on the ways is enormous. This fore poppet pressure has been calculated, and the ground-ways have been strengthened to stand it at the point where the poppet will be when the stern lifts. The poppet pressure should do no more than wipe the grease off the ways and perhaps make it smoke from the heat of the friction. A few seconds after the stern lifts, the fore poppet clears the ends of the ways, and the ship is afloat. Nothing remains to be done but to bring the moving ship under control, remove the fore poppet and the parts of the cradle which may be attached to the ship, and tow the newly launched vessel to the fitting-out pier for completion.

THE above description applies to an endways launching, this being the usual method of launching ocean-going vessels. The sidewise launching of the *Great Eastern* presented a different problem. Although the first attempt to get the *Great Eastern* overboard was unsuccessful, it must not be imagined that sidewise launching necessarily is undesirable. The technique of sidewise launching has since been highly developed on the Great Lakes, and many Lake shipyards use the method regularly.

A ship which is to be launched sidewise is built on an even keel, not on a slope, and she is, of course, built close to the water's edge and parallel to it. When she is ready for launching, a number of rather steeply sloping ground-ways are laid under the ship, extending only to the water's edge instead of into the water, as in stern-first launching. The water must be deep enough to float the ship at the ends of the ways, for she will not move any appreciable distance after leaving them. The ground-ways are greased as for an endways launching, and sliding ways are placed on them, with packing between the sliding ways and the ship. There are no poppets. The ship is held by triggers on two or more of the ways. Simultaneous release of these triggers lets the ship go with a rush. She drops off the ends of the ways with a most spectacular splash, rocks violently a few times and is safely afloat.

A ship launched sidewise has practically no tendency to run after leaving the ways and the method is, therefore, much used in restricted waters. Advocates of sidewise launching furthermore claim that there is less tendency to strain the hull than in endways launching, and that the ship may, therefore, be brought to virtual completion before going overboard without the resulting heavy weight causing excessive stresses during launching. There is, however, the risk of the hull slewing on the ways. This would result in the bow going overboard before the stern, or vice versa, which would undoubtedly set up severe, if not destructive, stresses. The danger of slewing is probably the reason that our largest ocean liners and men-of-war invariably are launched endways, though conservatism undoubtedly has something to do with it, a yard having a long and successful record with endways launching being naturally hesitant to adopt an unfamiliar method with a large ship. The devil-you-know is preferable to the devil-you-don't-know.

SO much has been said of the risks of launching large vessels that the question of whether or not these risks can be entirely eliminated naturally arises. The only way to eliminate the risks completely is not to launch the ship, and in some cases this is an entirely practical solution. A ship can be built and floated without launching her! This is frequently accomplished by building the ship in a dry dock of the graving dock type, and floating her out at any convenient stage of completion. At least six vessels, small ships to be sure, are now under construction in dry docks at east coast ship yards. One west coast yard has a dock that was specially constructed for shipbuilding and is used exclusively for this purpose.

Graving docks are large masonry lined basins much like canal locks. They are normally used for docking and repairing ships. The ship enters the flooded dock through an opening which can be closed with a watertight gate of some kind. When the ship is in the dock, the gate is closed and the water pumped

(*Please turn to page* 244)

Courtesy John Brown & Company, Ltd., Clydebank

Heaviest ship ever launched—the *Queen Mary*—entering the waters of the Clyde

OUR POINT OF VIEW

Age

POPULATION trends indicate, according to oft-repeated prognostications, that we shall become a nation of old people within the present century. The sense of this is not that science will give us everlasting life but rather does it mean that fewer children are being born while the average life span is being raised. New figures on phases of this question were made public almost concurrently by William L. Austin, director of the Bureau of the Census, and Dr. Robert E. Chaddock, of Columbia University.

Advances in the science and practice of surgery and medicine, improved sanitation, labor-saving inventions, and a higher standard of living, according to Mr. Austin, have added a decade to the average life since the turn of the century. Thirty-six years ago the average length of life for white males was 48 years and for white females 51 years; today the figures are, respectively, 59 and 63. Women still live longer despite the fact that they are no longer the "sheltered beings" of the Nineties, and have met the rough and strenuous competition of men in business! The figures show, too, that the number of babies dying in the first year of life has been cut in half. This contributes heavily to the raising of the figure for the average life span; but cynics say that science, in saving many physically unsound babies, is contributing to a higher mortality rate for later ages, that the first serious illness will take these off rapidly! All of us would like to be in that one-fourth of each male generation which will reach the age of 77, and some are hardy enough to wish to be in that one-tenth which will reach 83.

Approximately 6,500,000 persons in this country are now over 65, reports Dr. Chaddock. What luck for Dr. Townsend at 10 cents (membership dues) per week per oldster! But this is only a start —this group will be trebled in 50 years. There is little change in the proportion of the productive group from 20 to 44, reports Dr. Chaddock, but there has been a steady decline in the proportion of persons under 20 and a corresponding increase of those over 45. Mere man will be interested to learn that numerically, *at least*, there is a trend to equality of the sexes!

Many adjustments in our industrial and economic systems will be needed to take care of this aging population. Perhaps the most important thing is to give the productive worker the chance to support himself at a more advanced age. Otherwise, taxes to support him will skyrocket—or maybe they will anyway!

Radio Culture

EVERY now and then someone recalls the widespread early predictions that radio would prove of tremendous educational value and puts a blunt question as to the *proved* value of radio in education. Little discussion of this subject is heard nowadays and the puzzled inquirer takes it for granted that, having noted non-fulfillment of their prophecies, the idealists have backed water. It is pointed out often that the air waves are crowded with jazz, airy persiflage, and considerable clowning that is valueless except as entertainment.

The subject may well be re-opened with a slight revision of terms—a revision which carries us even beyond the original thought. Instead of "educational," let us use "enlightenment." The word education implies learning by rote or cramming of orthodox facts, while enlightenment covers the entire scope of man's activities. Book "larnin'" is only a small part of the broader culture which is enlightenment.

On such a basis, radio broadcasting has done so much good for all the people that we may overlook its more obvious faults. Radio education, or as we prefer to call it, radio enlightenment, is not the broadcasting of lessons, although certain stations have performed an admirable service to the public in this manner. Lessons are drudgery. Radio excels in broadcasting programs which millions follow because they are interesting, although they do not recognize these programs as educational. In pointing this out, General James G. Harbord, of the Radio Corporation of America, said that "Educators realize that the best teaching attracts and holds attention, while delivering a satisfactory and stimulating message. It is obvious that it benefits by what is loosely called showmanship."

Amazement has of late often been expressed at the conversation of the man-in-the-street on economics and sociology, politics and international affairs, war and peace, and the pros and cons of almost every conceivable subject. He reads neither the serious magazines nor newspaper editorials. But over the radio he has heard the voices of political candidates, of kings and dictators, of opera stars and commentators on everything under the sun. He has heard leaders in every walk of life, educators, lecturers, writers, scientists, as well as cranks and propagandists discuss and argue the subjects closest to their hearts. News broadcasts and radio dramatizations of events of past and present add to his vast store of knowledge and opinions.

There is your education! It is enlightenment and culture. It is progress. It is the fast-moving progress no other agent before radio was capable of achieving. And yet radio stands not entirely apart; it must go forward as a force for enlightenment in company and co-operation with books, magazines, and newspapers—onward to a glorious future culture!

Photographically Speaking

WE have frequently been asked by some of those of our readers who have not been bitten by the camera bug: "Why do you devote so much space to your 'Camera Angles' department?" The obvious answer, of course, is that a large proportion of our readers want news and information of the sort published under this heading. But behind this is something more, something that covers a lot more ground than just the photographic hobby itself.

To many scientific pursuits, be they vocations or avocations, photography has become an indispensable adjunct. From the laboratory technician, with his intricate research equipment, to the field worker in the science of archeology, from the amateur astronomer to the sports enthusiast, from the globe-trotter to the casual week-ender, the camera in some one or more of its multitude of forms has become an absolutely necessary medium for making permanent records of a multitude of things. Instrument recordings and excavated artifacts, new planets and a record-breaking high-jump, scenes in distant lands and the week-end hostess, all are recorded on the sensitive film, faithfully preserving exact detail for future reference.

With such a broad field of application, it is no small wonder that the science of photography attracts so many devotees who see in it something more than photography for photography's sake. The hobby, if you must think of it as a hobby, has such wide implications that it fits in neatly with almost anything else that you may be doing. This spirit, we believe, is reflected monthly in the columns of "Camera Angles," and is largely the reason why more cameras are being used today than ever before.

By ANDREW R. BOONE

COAST DEFENSE

WHEN a 200-mile-an-hour army bomber streaked across Muroc Dry Lake in southern California recently, dropping parachute flares and gas bombs over a mock battleship painted on the sand, while a second bomber a mile above dumped high-explosive bombs on the illuminated target, the art of bombing was revolutionized.

"Night bombing by flashlight," as the army bombardiers term the practice, means that while one or two planes bring illumination to a target on the darkest night while flying only 2500 feet up, the bomb-carriers appear a few seconds later. Thus the fire of anti-aircraft batteries is divided, and while the 7-mile-long beams from 800,000,000-candlepower searchlights follow the flare-dropping ships and the sound detectors are tuned to their powerful motors, those that do the real damage remain undetected until too late.

In the recent maneuvers, bombing squadrons of the 1st Wing demonstrated that they not only can speed overnight to the defense of any point along the Pacific Coast, but also proved that they can place their bombs accurately from great heights. From 20,000 feet, the flying hens loosed their "eggs" on the striped outlines of the battleship. Turrets made of wood and muslin, placed near the center of the "ship," were destroyed by the first salvo.

But the skilled pilots and bombardiers of the Air Corps do not conduct all their air raids with live bombs, for the giant one-tonners cost 750 dollars each. In their stead, during the recent maneuvers lasting 10 days and nights, they dropped 240 concrete bombs, the first time this type of dummy projectile has been used by any air force. All were manufactured on Muroc Dry Lake in metal forms, according to a formula worked out by Capt. Philip Schwartz, ordnance officer on the staff of Brig. Gen. Henry B. Clagett. Bottles of smoke screen solution fitted within the fin shatter on impact with the earth to provide a realistic "explosion."

TO avoid frequent landings for additional loads of bombs, an ingenious method has been developed whereby radio signals take the place of steel or concrete. For example: Orders from wing headquarters reach the 19th Bombardment Group to send up its bombers this afternoon for "radio bombing" flights, the trim planes to take off at one-hour intervals.

At one o'clock the first ship, carrying pilot, bombardier, and two mechanics, rolls down the tarmac at March Field, rises and quickly climbs to 8000 feet.

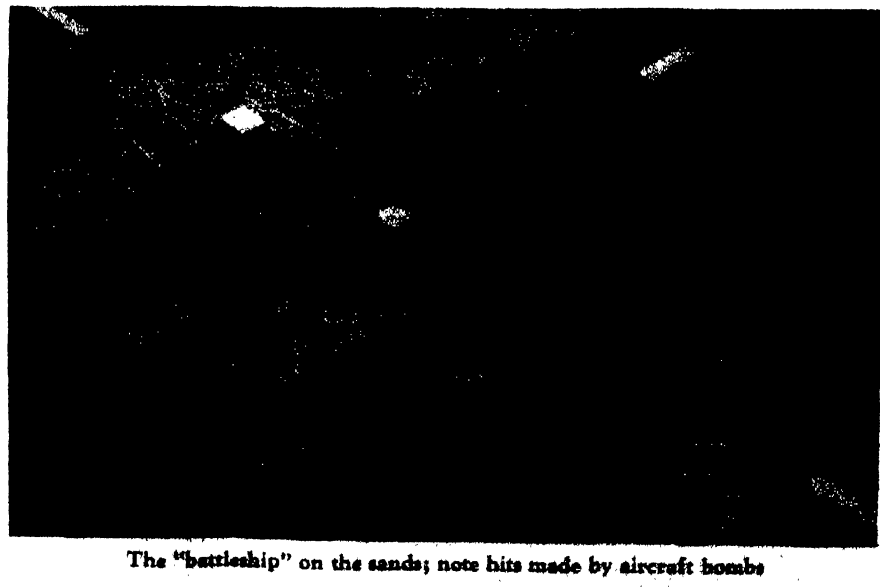
By 23rd Photo Section, Air Corps, U. S. Army

In the sheet-metal forms shown at the left are cast concrete "bombs" used by the Army Air Corps in practice maneuvers. These "bombs," with a device for giving out a cloud of smoke on impact, make possible extensive practice operations at much lower cost than with real bombs

Official photograph, U. S. Army Air Corps

Attack plane dropping gas bombs on "enemy" anti-aircraft battery from an altitude of 2500 feet, thus preparing the way for the large bombers that come over at 7500 feet. At night, the attack planes drop flares

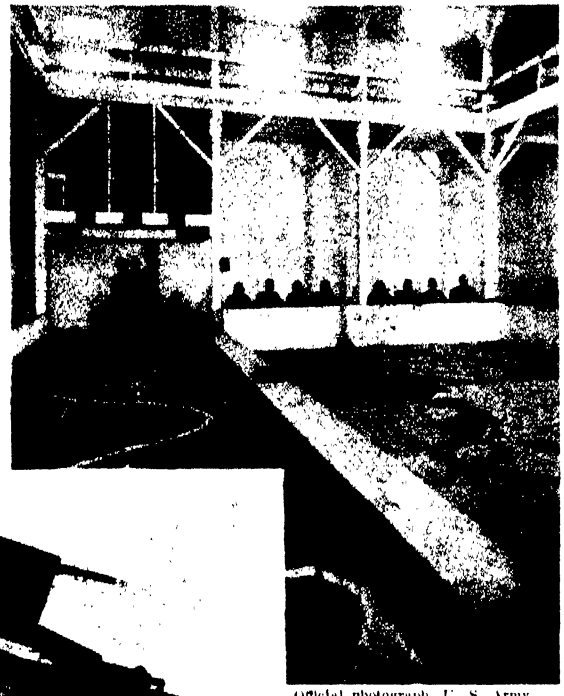
Placing one of the concrete "eggs" in the carrier of a huge bombing plane. These "bombs" cost 12 dollars, as compared with 750 dollars for live high-explosive bombs of the same size



The "battleship" on the sands; note hits made by aircraft bombs

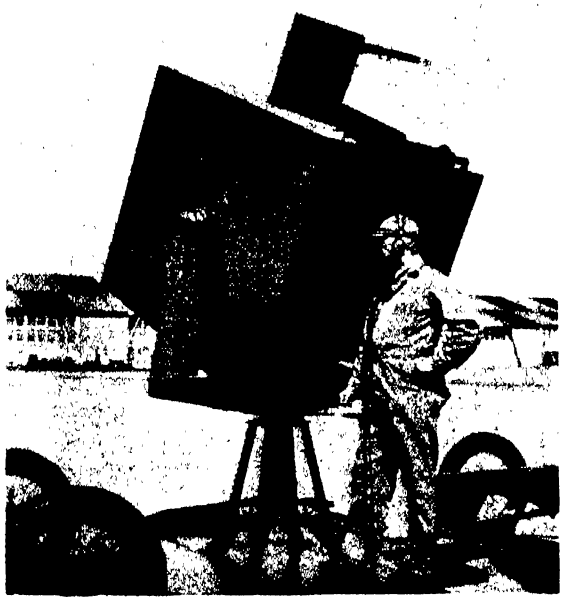
FROM THE AIR

Night Bombing . . . Deceiving Anti-Aircraft Gunners . . . Concrete Practice Bombs . . . Radio Bombing

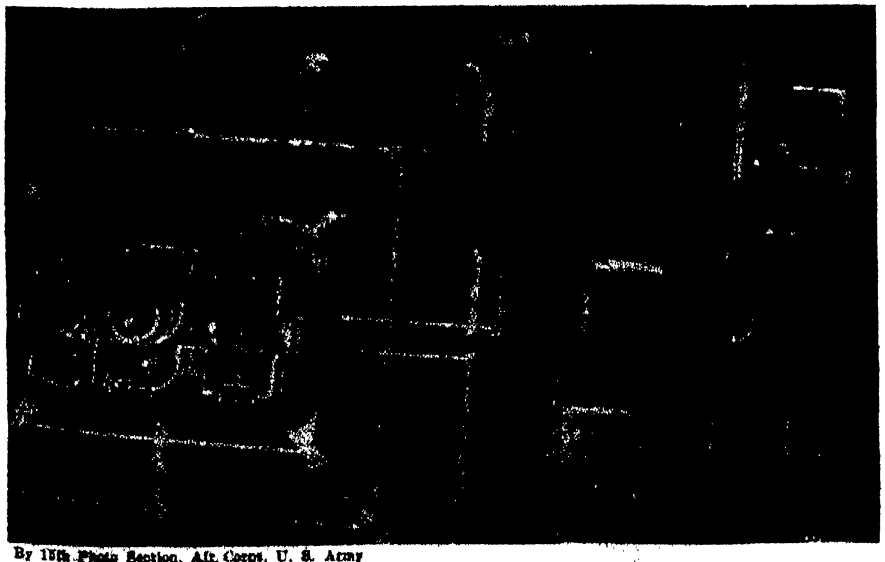


Official photograph, U. S. Army Air Corps

Aerial bombardiers being trained in an indoor range where the "landscape" is a moving curtain painted to show houses, bridges, airports, and so on. The men in training sight on a certain objective when given their orders, press a release, and their hits or misses are recorded by the scorer



The camera obscura hut used for training bombardiers in flight. Radio signals from the plane to the ground, sent at the instant when the bombardier has aligned his sights properly, enable the scorer to determine the accuracy of the trial. Time allowance is made for the bomb flight



By 15th Photo Section, Air Corps, U. S. Army

A night photograph taken by the light of a parachute flare

As the plane gains altitude a truck, containing two-way radio apparatus through which the pilot and ground crew talk to each other, drawing a box-like device known as a camera obscura, rolls out onto the concrete apron.

The camera obscura is in reality a tiny hut, mounted on a four-wheeled trailer, containing in the roof a lens which projects the plane's image on a large square of paper. As the plane approaches, its image moves rapidly across the chart. Aloft in the bomb bay the bombardier sights carefully on the distant target. He speaks into the plane's interphone system, directing the pilot along a path which will carry them directly over the camera. "Turn left," he orders, "steady . . . now right . . . steady . . . stop." Then he fires.

MEANWHILE, one of the operators has swung the hut around until the lens faces the on-coming bomber. Now its image appears at the top edge of the chart. Each second the operator pencils a tiny mark at the nose of the image. Soon through his ear phones a radio signal announces that the bombardier has pressed a button releasing the theoretical bomb, a costless dot or dash which speeds to the camera station at a speed as fast as light itself. But the observer does not stop here; he must allow for the time required for a bomb to fall 8000 feet. If the "shot" has been accurate, a mark will be made directly on the spot occupied by the hut.

When storm and fog close in on the flying fields, the men continue their bombing indoors. Three bombardiers sit on a platform near the ceiling; below them a device known as a "miniature range," which is a small-scale strip of terrain painted on a canvas, moves slowly on an endless chain. Below him, the bombardier sees bridges, railheads, farm houses, airdromes, highways, cities, and ammunition dumps, moving along as though he were flying above this scene.

Suddenly the commanding officer gives orders to bomb a certain target—a railway bridge, for instance. As the bridge moves into line with the cross hairs of the sights, each bombardier turns a crank to set his instrument for ground speed, keeping the cross hairs lined up on the target until an automatic signal indicates that the mechanical plane is set, and pulls the release handle when the target crosses a second point on the sight. This operation signals to the scorer, who notes the hit or miss.

THE MISTS OF MADNESS

By G. H. ESTABROOKS
Professor of Psychology at Colgate University

THE case was pronounced one of death by suicide. He was suffering from the "hand washing" mania. Every day, fifty times a day, he washed his hands. He had to. He tried everything he knew, got the best medical advice, but the mania persisted. So one day he took a hatchet, amputated his left hand, thrust his right under a buzz-saw and cured himself—permanently. A ghastly example of the "compulsion" in its worst form.

Then we have the "obsession." In a certain asylum a chap is spending his days by request—by his own request, strange to say. Everyone is staring at him—so he thinks—and it irritates him terribly, so terribly that he knows perfectly well he would commit murder if free. He deliberately chooses the least of two evils, for his case is hopeless. No power we know of can shake that nagging obsession.

Nor can we do very much more for the third of this group, the so-called "phobia" or morbid fear. I had an odd old acquaintance whose life was just one long dance on a frying pan because of his horror of cats. A kitten would simply make his hair stand on end, while a full-grown cat was just indescribable. His reaction, in pure self defense, was to establish a dead line around his house and any puss which crossed that sacred boundary mewed his last to the accompaniment of a shotgun. This peculiarity, needless to say, made him extremely popular with all neighbors and landed him before the police more than once.

I wish you would keep these three types of mental illness in mind as representing one broad group of "neuroses." Strange as it may seem, they all have a very simple explanation. There is a fundamental sanity to insanity, in these borderline cases as elsewhere.

NOW let us take examples from another group of the neuroses. The reason for this grouping will be explained shortly. For example, consider the "hysteric." His or her symptoms are legion, but the typical case of the lady who screams, faints, weeps, has terrific temper tantrums, and makes herself generally "charming" when her will is crossed will do as an example to bear in mind. Then we must place "perversion" in this second broad group. Here we have a very wide sweep of cases from the invert to those horrible cases of assault on little girls which certainly justify lynching if such justification can ever be obtained. We might cite as a third type of case belonging to this broad group that of the "hobo," the tramp who, from the psychologists' point of view, belongs to this lunatic fringe.

We do not, of course, wish you to infer that we cover all classes of the near insane in the above groupings. We merely choose certain cases to illustrate what we will say later. Nor are all these cases clear-cut and dramatic. Compulsions run everywhere, from your own tendency to "knock on wood," through such relatively harmless cases as Samuel Johnson's touching every other lamp post, up to the very serious "hand washing mania;" obsessions from your own uncomfortable feeling that your neighbor is talking about you, through your very definite dislike for Protestant or Catholic, Negro or Japanese, up to those serious cases which may very easily end in murder. Phobias are countless. We have fear of closed spaces, fear of open spaces, fear of light and fear of dark, fear of water and fear of sand, even fear of fear. Some phobias are so slight as to make no impression whatsoever on the individual; others cripple an entire life.

In this article we are mainly concerned with the borderline cases which can be pretty clearly distinguished from those in which the individual is completely insane. These people on the fringe are only the part-time insane, so to speak. The chap with the hand washing mania is quite normal when he doesn't have the urge to wash his hands. The fellow who fears cats doesn't worry about rats or dogs. Keep cats away and he is quite happy. The pervert passes for normal among most of his friends, and the hysteric is quite a charming person —sometimes. In other words, this borderline group is still in touch with reality. A large part of the time the individual lives in a real world and acts like a normal human being. Suddenly a cat appears on the horizon or someone stares at him; then, for the time being, he is as insane as the best of them. One writer sizes up the condition of these cases by saying that they have one foot on reality and the other on a banana-peel. Results depend on where they put the pressure.

Despite the great differences which seem to exist between various types of mental disease, the explanation of insanity is relatively simple. Either there is damage to the brain or there is not. Syphilis of the brain, tumor, a fractured skull, or other factors may temporarily or permanently upset the individual's mental balance. Here the causes are more or less obvious. But those cases we have been citing have nothing wrong with the brain. Examine their thinking apparatus after death and it is just as good as yours or mine. Then why the insanity?

The answer is fairly clear and can best be given by referring you to your camera. Your brain is essentially a photographic plate, but there are several ways of getting at it. One set of pictures comes in through the eyes, but the plate can also be reached through the ears, the mouth, the nose, the sense organs in the skin and others. We can lump all these together in a very simple manner under the word "attention." Whatever has your attention at any particular moment, be it a good picture, a bad smell, or a boring lecture, coming through eyes, nose, ears, or what you wish, is registering on the camera of your brain. This is simply what you call learning, and all insanity of the type we are considering is learned. Your acquaintance is unbalanced or on the borderline because he has learned how to be insane. Moreover, in the great majority of cases, he has gone insane for exactly the same reason you go to college. It pays. More of this later.

THE near insane and the insane are as they are because the camera of the brain worked too well. This camera is peculiar, in that it has a remarkable sensitizer—emotion. Under normal conditions your brain works with average efficiency. Any emotion, however, such as fear, love, or hate, immediately jumps its efficiency in very marked fashion. The camera plate becomes very sensitive and anything which occupies your attention at that moment becomes burned in so deeply that in many cases it never can be erased. For instance, a soldier in a moment of intense fear had his eyes glued on a German helmet. Fear sensitized the brain, and the helmet was the object of his attention. Result: a case of "shell shock," in which the main symptom was the vision of this helmet and the face beneath it accompanied by great terror. Another soldier was standing in front of his dugout when a shell

Borderline Insanity and Full Insanity . . . Types of Neurotics and Why They Exist . . . Types of Insanity and What Can be Done About Them—Not Much

passed between his legs but did not explode. At that moment of intense terror his attention and his right hand were occupied with his upper lip. As a result his arm was "frozen" in this position. He was unable to lower it.

This is exactly what happened in the cases cited in the first paragraphs. For instance, the hand washing maniac as a child got his hands in filth, was terribly disgusted and at that moment the thought uppermost in his mind was of washing his hands. Result: a hand washing compulsion. The cat phobia is quite clear. As a child a cat, whose kitten had just been killed by a dog, went mad, flew at the boy and bit him badly. The case with the obsession of staring is not so clear. Records cannot always be obtained. It is probable that, as a child, when intensely angry he was forced to do the will of a parent by being "stared down." Other cases would indicate some such explanation.

THIS principle of brain sensitization through emotion is essential to the understanding of all mental disease which does not involve actual brain injury, such as a tumor. We do, however, need another hypothesis to obtain a complete picture. This is the famous "pleasure" principle, which is simply another phase of our first, and explains not so much how they got that way as why they stay that way. It states that man will at all times seek pleasure and avoid pain. The pleasure may be remote, as in the case of the martyr at the stake seeking heaven or yourself in the dentist's chair avoiding a future toothache, but the principle always holds. Not all, but the great majority of mental cases are where they are because they enjoy it. They are incurable because they don't want to be cured. It is a pleasure for them to be sick and, like all sensible people, they intend to stay that way.

This is very well illustrated by that second group of cases from which we chose hysteria, perversion and the hobo as representatives. The working of the pleasure principle is splendidly seen in the hysteric. Johnny has not got his lesson ready, is certain to be punished and does not want to go to school. The fear aroused under such circumstances is far greater than we adults realize. As a last desperate move he plays sick. The result is miraculous. He finds himself the center of attention and he sidesteps school, both at one blow. Then Johnny does what any sensible child would do under the circumstances—he cultivates this marvelous source of power. Fortunately the attempt generally ends in disaster, to the tune of a slipper on the rear end. But sometimes the child scores a brilliant success. He learns to sidestep every responsibility and center sympathy on himself by feigning sickness. Then, as the years go by, he learns his lesson too well. The fake stomachache becomes "nervous" indigestion when faced with any strain. The childish tantrum becomes a genuine hysterical "fit." He really cannot control the symptoms any longer and he illustrates beautifully the working of the pleasure principle in these margin cases—for it almost always "backfires." The pleasure is generally far outweighed by the pain which results.

This principle of brain sensitization, plus the pleasure principle, is also well seen in the case of the pervert. Here the individual learns to gratify his sex urge along homosexual lines. The emotion which sensitizes the brain is obvious. Fully 95 percent of these cases are the result of learning by seduction at a relatively early age. Also it is very obvious that there is definite pleasure associated with these activities. And, just as clearly, there is a very grave danger of "backfire," for the life of the pervert is no bed of roses. As the old darky put it, he's always "on the edge of a verge." One false step and disgrace, even imprisonment, are the rewards which society offers him.

ALL of which, I think, gives us a very neat classification of these near insane wherein no brain injury is involved. Basic to all is the idea of brain sensitization through emotion—through *any* emotion be it pleasant or unpleasant, such as fear. Some impression occupying the attention at that time, be it a cat, a movement of the arm or the basis of a perversion, is indelibly burned into the brain. That is the picture and the whole picture in our first type of neurosis as represented by the compulsion, obsession, or fear.

But note that in our second large group, as seen in the hysteric, pervert, and hobo we have the pleasure principle added.

The individual deliberately repeats the original experience everytime he gets a chance. The hysteric enjoys being sick, the pervert would not be otherwise even if he could, and the hobo is having a lovely time. For that reason this group tends to be the more numerous and almost wholly incurable. Your hand washing mania case does *not* enjoy it. He really wants to be put straight. The case of the cat phobia certainly would never go around looking for mad cats to bite him—which is exactly what the hysteric or the pervert does. As a result the phobias will at least do their best to get well, whereas the hysterics will do their best to stay ill.

We would like to complete our picture by showing how this same line of explanation applies to the cases of real insanity—the "psychoses" which you see in the asylum. We can illustrate from the "big three"—dementia praecox, paranoia, and manic-depressive insanity. Do not be worried by the names, for they are all to be explained very simply. All these types are pursuing the pleasure principle in somewhat different ways, but the real insane, believe it or not, are the lot who are really logical. They illustrate in true form the sanity of insanity. Take your case of dementia praecox. This type of insanity is very common; in fact, the majority of cases in any asylum would come under this head.

THE patient who suffers from dementia praecox is living in a world of dreams. He sits in a corner all day long smiling to himself, making senseless movements with his hands, or wanders aimlessly about talking utter nonsense. But he is really having a grand time. His dreams have come true—because he lives in a dream world. For him you simply don't exist. If you can get him to talk he will give you a marvelous story of how he has a bride on the moon, a palace at the South Pole with an orchestra of polar bears, or ten billion dollars in the local bank. Name it and you can have it! He represents the perfect working of the pleasure principle. He got his start the same as our other cases, only the emotion was always pleasant. Then he made the very wonderful discovery that it was really almost as much fun to *imagine* you were doing something very nice as to do it. Besides, it took much less effort and you couldn't fail. So he began using his imagination more and more, becoming less and less interested in this cruel, sordid world until he just forgot about it completely and day-dreamed his way right into Heaven. For that is where he is. He's happy and will always remain so in spite of depressions or new deals.

Paranoia is just as interesting. This is the chap who thinks he is Napoleon, Alexander the Great, or George Washington. We say he has delusions of grandeur. He also has delusions of persecution which make him a very dangerous type of madman. Strange to say, his brain remains quite clear, he knows where he is and what he is doing, *but*

he is Napoleon, for all that, persecuted by his enemies. Like anyone who is being persecuted he is very likely to hit back, and his clear mind makes him all the more dangerous. But the working of the pleasure principle is obvious. He really believes he is Napoleon, feared and persecuted by the entire United States. As such he feels very important —and very happy.

Manic-depressive insanity does not give nearly as convincing a picture. The typical case has a period of mania in which he is literally on top of the world —so much so that he has to be locked up. Then he will have a fit of depression in which he will weep for weeks on end. The whole thing may then clear up and never return, or it may return at certain intervals. The working of the pleasure principle is obvious in the manic state but not so clear in the depressed. In fact, we suspect that there is an actual organic basis for this psychosis but as yet we know too little about it to make definite statements.

WE can now get a very consistent picture of mental disorder if we think back through the article. Remember that we are talking only of those types in which the brain is not injured. First and least important are those disorders which demand only the theory of brain sensitization by emotion. We illustrated from compulsion, phobias, and obsessions. A picture is printed indelibly on the brain but the subject does not like it. He does everything in his power to cure the condition and conceal the symptoms. So this type tends to be the least numerous and least severe. The next group, however, as represented by hysteria, perversion and the hobo, tends to be much more crippling because here we see the pleasure principle at work. The patient enjoys being ill, he re-exposes the photo plate on every occasion, so to speak, and parades his symptoms in so far as he dares. Both of these groups—the neuroses—tend to be on the lunatic fringe, but they are still tied to reality.

Finally you have just to carry the same principle a step further and you have the hopelessly insane. They have carried the pleasure principle through to its logical conclusion. They actually believe their own delusions, live in a world of dreams, cut themselves entirely clear from reality and are, perhaps, the happiest of all mortals.

So there is your picture. Then why dòn't we do something about it? The answer is obvious—we can't! The dice are all loaded against us. The first group offers some hope, but here you have the analogy of your photo plate. Over-expose your plate on a cat fight, take it down to the photographer and tell him to remove all traces. He may be able to do a great deal or nothing at all. It depends on how much exposure you got and how sensitive was the plate. The bets are that he will leave some lasting scars.

With the last two groups, however, the odds are all in favor of your wasting your sweetness on the desert air. The hysteric, for example, will do everything in his or her power to block a cure; the dementia praecox is so supremely happy that he won't even take time to give you a hearing.

DUE perhaps to a natural human tendency to sort things out and classify them sharply in regimented compartments, all neatly and ideally arranged where they can be counted and weighed and appraised statistically, many persons have gained the impression that it is possible to make definitely sharp diagnoses of each case of insanity and to say, in given instances, "This man is a schizophrenic (dementia praecox), that man is a paranoiac, and that one a manic-depressive." Unfortunately the actual cases do not always stack up just that way, and very often a given case exhibits some of the symptoms of several types of insanity or of neurosis. Hence if your friend—or enemy!—whom you suspect of being just a bit "peculiar", fails to fit exactly some one of the descriptions given, do not give up hope—he may still be whatever he is.—*The Editor.*

There are really only two possible ways of dealing with these mental disorders when the pleasure principle is involved. You can offer a line of conduct that gives more pleasure, or you can make the present line of conduct so painful that they will avoid it. The first looks hopeful but does not yield much result. The pervert or hysteric reacts to this treatment in much the same way as would the average American if you tried to compel him to substitute snails for oysters on his dinner menu. You could present the most convincing arguments proving that, once he came to like snails, they would be much better for him and he would really enjoy them far more. He might admit it—to your face. He might even try snails—once or twice. Then he would probably send both you and the snails to the devil—which is just what the mental cases generally do.

Nor is the attack through discipline much better. Something can at times be done. One army doctor was in the habit of curing shell shock, which arose from a desire to avoid danger, by glaring at the patient and announcing, "Now, my man, there are just two people who know what's wrong with you. I'm one—you're the other. If you aren't *cured* in 24 hours, I'll send you up for a court martial." He cured most of his cases. But you can't keep on swinging a whip indefinitely over peoples' heads and expect lasting results.

The only attack on the problem is through mental hygiene in childhood. In other words, prevention. Almost all of these conditions arise before the age of ten at the latest. Our great enemy is the pleasure principle, which, as herein illustrated, always causes trouble by carrying over *childish* pleasure into adult life. "God bless father and mother, and make them happy—if they're not too old for that sort of thing," was Johnny's famous prayer. Our whole training of Johnny must be based on the realization that some day he will be an adult, and that society will either lock him up or make him very unhappy indeed if he *is* "too old for that sort of thing" on the adult level.

THUS, the neurotic presents one of those contradictions so often seen in psychology. He is as he is because of the pleasure principle. He resolutely resists treatment for the same reason, yet he may be very unhappy. His pleasures are those of the child but he lives in an adult society. Nor can he ignore that society, try as he may. Despite his ridicule of convention and his passionate demand for self-expression, he knows that he walks between the devil and the deep sea—between the asylum on one hand and prison on the other. Let him but overstep those despised conventions and society is ruthless, regardless of his ruination, as indeed it must be in self-protection.

Under the strain of modern life we may expect an increase in mental disease. Normalcy involves the facing of reality in an adult world, an assignment which is becoming less and less attractive as civilization becomes more complex. Our only hope, if hope there be, of stemming this rising tide of maladjustment, lies in education.

We must teach the child to face reality in an adult world. That is a tremendous task, for which we must learn to recognize those signs which tell us that the child is becoming wedded to childhood pleasures. Then we must perfect a technique with which we can change his diet, all to be so simple that the average school teacher can understand and apply at least the broad principles.

Progress? Very slow, for the problem is far from simple. Under the guidance of such organizations as the National Committee for Mental Hygiene we are at least learning to visualize the problem, but we may truthfully say that, up to now, our progress has indeed been slow in actually dispelling the mists of madness.

THE SUN REAWAKENS

By ALBERT G. INGALLS

May 14, 1936

May 15, 1936

A quiescent type of hydrogen prominence, changing but little in a day

"TRUE to the prediction of the 'eleven year cycle,' solar activity is increasing and for two or three years the sun should prove a most interesting object for the observation of sun-spots and prominences." Four years ago[1] Scientific American contained an article entitled "One Man Who is Having Fun," which told how Gustavus Wynne Cook, of a Philadelphia suburb, had created an unusually large and expensive private astronomical observatory. A later article[2] described further additions to this observatory, and stated that a staff of professional astronomers was being maintained by Mr. Cook. Since then the Cook Observatory has received further additions in staff and equipment, and is now regarded as a part of the professional astronomical commonwealth of the nation and world.

The opening sentence, quoted above, is from a communication from Mr. Cook, who also sent some photographs of solar prominences which are shown on this page. They were taken this year at the Cook Observatory, by means of a spectroheliograph. In looking at these vast outgivings of heated solar gases the reader should keep in mind the relative scale of size, which is provided by the small circles afterward placed on the photographs by Mr. Cook. These represent the earth on the same scale, and the convex curves are those of the sun's surface. It is fascinating to imagine the earth exposed for a single second to a flame the size of the prominences shown: like a butterfly in a bonfire, singed, seared, and despoiled in a moment.

Every 11.2 years (on the average) the number of sun-spots gradually increases from almost none to several hundreds per year, and more or less in unison with this the number of solar prominences increases also, from none to 20 or 30 visible at any one time. Beams of electrons are shot out of sun-spots and these sometimes strike the earth, causing magnetic storms and auroras.

The last previous period of maximum sun-spot and prominence activity occurred about the middle of 1928. Therefore the next peak is due in 1939. We have already passed the dip between these two maxima, and at present are well up the rising part of the curve toward the new one. As Mr. Cook's comment at the opening of this article implies, some interesting things connected with the sun are on the make at present, and will be on the make for two or three years to come. Astronomers, both professional and amateur, become more sun-conscious at such times as this.

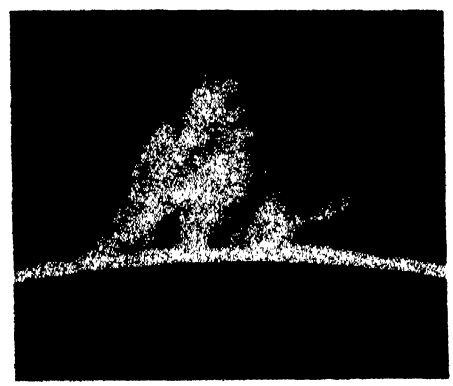
Solar prominences are projections from the upper layers of the sun's atmosphere of hot gases, and their color is predominantly red. Thus the reader will be fully justified by scientific facts if he imagines the "flames" of the hydrogen prominences shown on this page as red. Nor is the red of hydrogen prominences a faint or filmy thing called red by mere courtesy, as in the case of some of the "colored" stars where the observer must almost be first hypnotized in order to believe he sees the faint color of the star as described in books about the pretty stars. When a hydrogen prominence is seen through a Hale spectrohelioscope, visually operated brother of the photographically operated spectroheliograph with which these photographs were taken, he sees them red—as frankly and definitely red as grandfather's red flannel underwear. The reason: atoms of hot hydrogen radiate in wavelengths which excite the sensation of red on the retina.

At the top are two photographs (more precisely, spectroheliograms) of a "quiescent" type of hydrogen prominence, which Mr. Cook has called the "Dog Prominence" because of its shape. These were made at an interval of 24 hours. Quiescent prominences behave in a relatively lazy manner, often lasting several days with only slow changes in form. The three lower spectroheliograms exhibit the other type, the eruptive kind; no lazy floating or drifting here! They sometimes shoot up at the rate of 200 miles per second. Regarding this one Mr. Cook writes, "This eruptive hydrogen prominence was first photographed at 11:48 a.m. and again seven minutes later, and again eight minutes still later, at which time it showed a height of 80,000 miles and a breadth of 75,000 miles. This prominence," he adds, "was of unusual size—the largest eruptive prominence for several years."

[1] August 1932, page 74.
[2] June 1935, pages 318-320.

11:48 a.m.

11:55 a.m.



12:03 p.m.

An eruptive prominence of immense proportions, which shot up at great velocity on April 14, 1936

Mystery Shafts of Ipswich

Suspicions of Roman Age . . . Strange Condition of Affairs . . . A Peculiar Feature Was Observed . . . A Foxy Trick But Not Foxy Enough . . . Suspense

By J. REID MOIR
President of the Ipswich Museum, England

FROM the archeological standpoint the brickfield of Messrs. Bolton and Co., Ipswich, England, may perhaps lay claim to that frequently misused title—unique. For a considerable number of years a close watch has been kept upon the diggings for brickearth there, while extensive excavations have been carried out for archeological purposes. This work has resulted in getting together flint implements ranging in date from the earliest to the latest relics of the Bronze and Iron ages, and very numerous remains from alluvial ground of the late Roman period. But the interest of the Ipswich brickfield has recently been greatly increased by the discovery there of three very deep, filled-in shafts of a type hitherto unknown in England, and in some particulars, unlike those found elsewhere.

The shafts lie roughly in an east and west line and about 10 feet distant from each other. They are all of a remarkable character. The shaft first uncovered shown at the right side of Figure 1, proved to be a clay-lined cylinder—approximately three feet ten inches by two feet four inches in internal diameter, which passed down through the harder clay and deep into the underlying Eocene sand. The walls of this structure averaged nine inches in thickness (in places where extra strength was required, they were considerably thicker), and were made from puddled clay smoothed off on the inside by some instrument, probably of wood, which occasionally had left its impress upon the surface of the wall. The shaft was filled with a peculiar loamy material evidently brought from some other part of the brickfield, and was practically devoid of archeological relics. In fact, the only thing of the kind found in the shaft, and about 16 feet from the surface, was a small fragment of pottery which is believed to be of early Roman antiquity. The other discovery made in the infilling was a piece of matted hair, referable to either the badger or rabbit, lacking in any recognizable significance. It is of interest to note, however, that a precisely similar piece of matted hair was found in the infilling of the neighboring shaft while this was being excavated.

Shaft Number 1—the clay-lined cylinder—was traced to a considerable depth without reaching its base, and it was decided, in view of the peculiar and somewhat dangerous conditions attending its examination, to devote attention to the neighboring Shaft Number 2, shown toward the left in Figure 1. This presented a fundamentally different appearance (Figures 2 and 3) from Shaft No. 1, being some six feet in diameter, and filled in, as to its uppermost 18 feet, in a careful and elaborate manner. The center of the shaft, marked *A* in Figures 2 and 3, was composed of a pillar of puddled clay, some three feet wide, and with a rounded base, while its periphery was outlined with a layer of black pebbles, marked *B* in Figure 3 and sketched in Figure 2, evidently procured from a deposit of these which occurs in the immediate vicinity of the shafts. Between the central pillar or core of clay and the main walls of the shaft, had been built two walls of whitish clay with a globular base (*C*, in Figures 2 and 3). These subsidiary walls did not wholly surround the central mass, but had been built on either side of it. Between them and the walls of the shaft, and the central core, had been placed sand. Very careful notes and drawings, supplemented by photographs, were made of this strange condition of affairs, representing in all probability a ceremonial sealing in of the shaft. Below the 18-foot level the infilling was of a haphazard nature.

In both shafts Numbers 1 and 2 a peculiar feature was observed, in that, at some considerable depth from the surface, the clay walls of the shafts coalesced, forming a basin extending over the whole internal area (*D*, Figure 2). It is difficult to explain this, but it may represent a device to induce any later excavators of the shafts to imagine that they had reached the bottom, and thus abandon their enterprise. In the present case, however, the use of a metal probe at once showed that the shafts extended downward below the clay basin, and the work of excavation proceeded. The investigation showed that the shaft was roughly bottle-shaped and passed through a great depth of sand lying upon the chalk. When the latter was reached, the excavation changed in character, assuming in plan a more or less hourglass form, and this was continued as far as the recent diggings extended.

Unfortunately, soon after the chalk was reached, a great and increasing quantity of water was encountered, necessitating the use of pumps for its removal. The use of these gave rise to

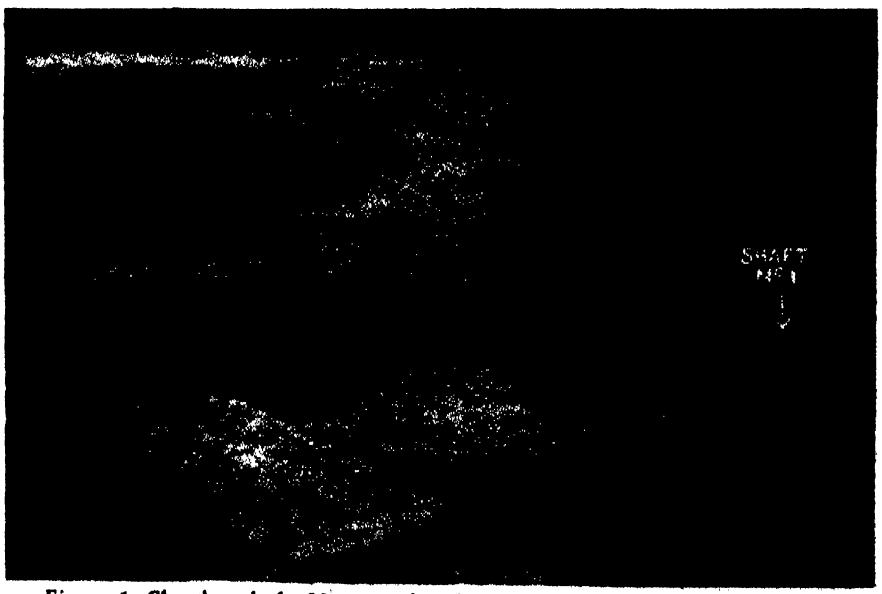


Figure 1: Showing shafts No. 1 and 2. In excavating, the earth was carefully dug out from around the two shafts, leaving them standing partly in the clear

much trouble and expense, and, upon a depth of about seven feet from the surface being reached, the inflow of water rose to some 15,000 gallons per hour. To cope with such an inflow still more powerful pumps would have been required, but the financial resources available were not sufficient to meet the necessary expenditure, and with great reluctance the work had to be abandoned. Its undertaking had made necessary the use of timbering and was not devoid of danger, but fortunately the digging was carried out in safety.

IT became clear that the ancient excavators had used a primitive form of timbering in sinking the shafts, as impresses of this were visible in places on the outside of the infilling. From an examination of these impresses it seems that the wood used was split off the outside of a tree trunk, as one side was approximately flat, while the other was convex. Several small pieces of wood were found in the infilling of Shaft Number 2, and these probably represent fragments broken off when the timber was drawn as the infilling of the shaft proceeded. Pieces of chalk bearing pick-marks were discovered considerably below the present water level in the chalk, showing that this level has risen some distance since the days when the shafts were originally dug.

It is to be regretted that, as with Shaft Number 1, the infilling of Shaft Number 2 yielded very little of an archeological nature, but what was discovered may be of considerable significance. When the chalk was reached two pieces of silver sheeting were found, and these the authorities of the British Museum think may represent part of the fittings of a casket or treasure chest, broken off when it was being lowered into the shaft. A fragment of polished marble also discovered may, too, have formed a part of such a casket.

At a lower level than these relics were found a *pavé* of chalk flints placed close together and covering the whole interior area of the shaft, *E* in Figure 2, and some pieces of brick, apparently of Roman date, which have the appearance of having been broken off during the building of some structure.

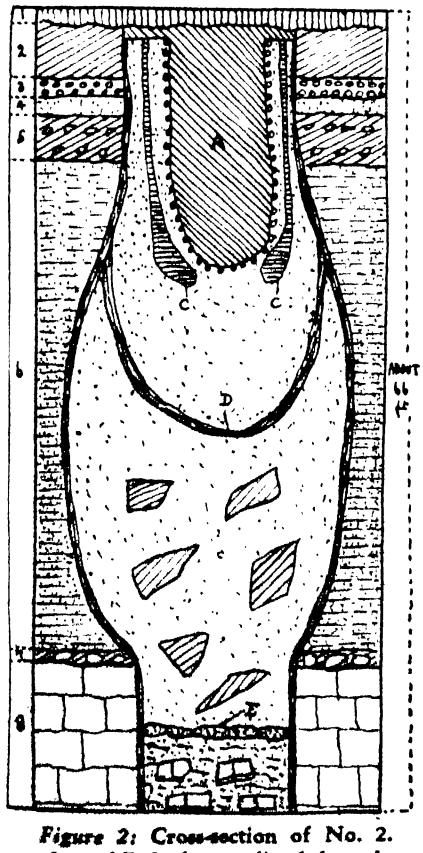


Figure 2: **Cross-section of No. 2. *A*, puddled clay outlined in pebbles. *C, C*, whitish clay walls. *D*, the "trick" (?) wall which did not trick. *E*, a *pavé* of chalk flints**

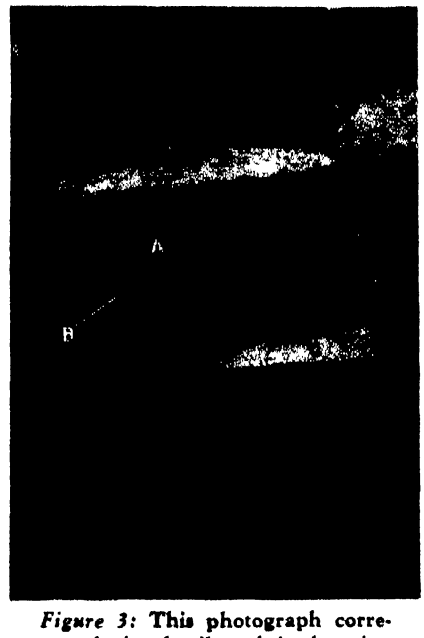


Figure 3: **This photograph corresponds in detail and in lettering with the cross-section at the left, except that it exhibits only a third or somewhat less of the total depth of the wall, as indicated at the right side of Figure 2—i.e., "about 66 ft."**

Another curious feature was provided by the unctuous clay material about three inches thick, covering the walls of the shaft where it entered the chalk. This material, which contains an appreciable quantity of hair, has been analyzed, and found to possess a considerably larger amount of what was originally organic matter than is present normally in ordinary geological deposits in the brickfield and neighborhood. It is conceivable that if blood (the result of some sacrificial rites) had at one time been present in the shaft, this would account for the abnormally high organic content in the material.

Figure 4: **The timbered mouth of Shaft No. 2, showing the equipment used in the excavation. Arrow points to filled-in portion of Shaft 3**

It is thus apparent that these shafts (Number 3, Figure 4, resembles Number 2 and remains unexcavated) exhibit many mysterious aspects, and it is greatly to be regretted that their complete excavation was not possible. If adequate funds were available there is little doubt that the site, which is in danger of being built over, could be successfully examined, and it is highly probable that objects of much archeological interest and value would be recovered.

THE shafts are situated close to a Roman burial ground, and about a quarter of a mile from the Roman Villa at Castle Hill, Whitton. It would seem likely, therefore, that the excavations are to be associated with Roman times. This view is strengthened by the discovery in France of what are known as *puits funeraires*, which are deep shafts —some penetrate to a depth of 120 feet —of the early Roman period. It was the custom in those days to bury the ashes of the dead in cinerary urns, and accompanied by numerous funerary objects, in such shafts with, it is supposed, the two-fold view of protecting the departed, and preventing haunting of the living. Many of these funerary objects are of great beauty and value.

Other burial shafts of the late Roman period, such as those of Cyprus, led down to a chamber or chambers where the coffin was placed, together with a wealth of funerary furniture. It is not possible to say whether the Ipswich shafts belong to one or either of these periods, but their association with the Castle Hill Villa of late Roman date would point to their being of the latter epoch. In any case, the recent excavations have opened a new chapter in English archeology and filled those who carried out the work with profound admiration for the skill with which the ancient shaft-sinkers overcame the many difficulties which confronted them.

NEW LIGHT ON THE

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society.

ONE of the most perplexing of astronomical problems is the origin of our solar system. It presents a large central body surrounded by many small ones, all revolving about it in nearly circular orbits close to the same plane and in the direction of rotation of the central body; and this property is repeated four times in the satellite system of the planets from Mars to Jupiter. This cannot be an accident. Some orderly process must have been operative. The earth's large satellite and Neptune's, which revolves in the opposite sense to the planet's rotation, look more like peculiar cases of the operation of such a process than like absolute exceptions. Yet a century of investigation has served mainly to emphasize the difficulty of even guessing what really happened.

Laplace's old theory—that a large nebula, flattened by its rotation, shed, as it contracted, ring after ring from its periphery—was overthrown toward the end of the last century by simple dynamical arguments based on the principle of angular momentum.

This might be described in Newtonian language as the "quantity of rotation" of a system. Take the mass of any particle, multiply it by its distance from an axis (passing through the center of gravity of the whole), and again by its velocity in the direction in which rotation about this axis would carry it, and we have the angular momentum of that particle. Add all these and we get the angular momentum of the whole system. It is important because, as follows at once from Newton's laws of motion, this total angular momentum cannot be altered by any forces acting within the system between its parts, even if they involve friction and degradation of energy. It can be changed only by influences from outside.

NOW more than 98 percent of the angular momentum of the solar system resides in the orbital motions of the planets. The sun's rotation is so slow that it adds very little. Yet the planets all told have but $\frac{1}{7}$th of 1 percent of the total mass.

A process which, without external aid, would concentrate 98½ percent of the rotational momentum of an isolated system into 1/700 of its mass would have been very extraordinary. Indeed, careful mathematical studies by Moulton, Jeffreys, and others, show that it would be more than extraordinary: it would be dynamically impossible.

This great obstacle was cleared in 1900 by Chamberlin and Moulton who suggested the first form of the "encounter theory." According to this, a star, coming from the depths of space on a path which happened to pass very close to the sun, caused by its attraction great eruptions of matter from the sun's intensely hot interior. Some of this molten matter fell back, some may have been carried off by the star, but the rest

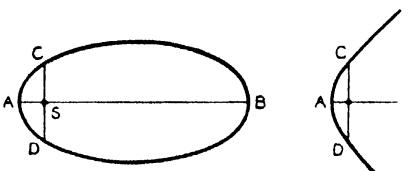


FIG.1 FIG.2

was set into motion laterally by the star's attraction and remained circulating around the sun, after the star had receded into space, in orbits nearly in our plane. Whether this matter originally congealed into a multitude of small "planetesimals" which later became aggregated into the planets, or whether the latter were of nearly their original size from the start, is a detail—important, but less so than the main idea. Jeffreys and Jeans have presented convincing arguments in favor of the latter alternative, attributing the ejection of the planets to the action of huge tidal forces as the star almost grazed the sun. Jeffreys has later gone further and assumed that the star actually hit the sun in a "side-swiping" collision. This form of encounter accounts for the relatively rapid rotation of the planets better than the others, but the whole set of hypotheses meets with very grave difficulties and once more on grounds connected with angular momentum.

It follows from the laws of gravitational motion that there is a simple relation between the angular momentum per ton possessed by a body moving around the sun and the size of its orbit—provided that this "size" is properly measured. Instead of taking half of the longer axis of the elliptical orbit (*AB* Figure 1), we must draw a line *CD* through the sun perpendicular to this and take half of *CD*. The angular momentum per ton is then proportional to the square root of this distance. This proposition still holds good for a parabolic or a hyperbolic orbit (Figure 2). For an elliptic orbit (Figure 1) the perihelion distance *AS* is always more than half of *CS*; for a parabola it is just half; for a hyperbola, smaller. Now, in order to disrupt the sun by tidal action, much more to collide with it, the star must have come so close that *SC* could hardly exceed 5,000,000 miles. The total angular momentum of the star as it moved about the sun must have been enormous, but the angular momentum per ton would remain small—about one quarter of that possessed by the earth in its orbital motions and less than 1/20 of the value for Neptune.

To get the planets out of the sun and give them orbital motions of their present type, the star would have had to impart to them very much more angular momentum per ton than it itself possessed. The difficulty of devising a process by which the angular momentum of many tons of the star's mass could be concentrated into a single ton of the ejected material is as great as the older one which wrecked the Laplacian theory. Moreover, even if it could have happened, the distance *SA* would have been but a few millions of miles, while *SC* (corresponding to the angular momentum per ton for most of the planets) would have been hundreds of millions, so that the mass would have flown off in a hyperbolic orbit and never returned.

THE writer of these lines pointed out this difficulty a year or two ago but saw no way to get around it. This has now been done with marked success by Mr. R. A. Lyttleton, a young Englishman holding a visiting fellowship from Cambridge to Princeton.

The writer had considered in a general way the possibility that before the birth of the planets the sun had been a double star, and that it was the other member of the pair that got hit by a passing star; but he saw no way of getting rid of the main mass of this companion and of the intruding star and leaving stuff enough to make the planets. Mr. Lyttleton has shown by simple reasoning that it would have been entirely possible for the third body to impart such a speed to the companion that it was sent off into space in a hyperbolic

ORIGIN OF THE PLANETS

The Lyttleton Theory, New Explanation of Planetary Origin, Which May Continue To Be Heard Of . . . Extant Explanations Did Not Wholly Satisfy

orbit without being itself so much slowed that it was unable to escape from the sun's attraction. (The alternative that the companion was ejected and the interloper captured is also possible but does not concern the present problem.) Suppose that the companion and the interloper actually collided. As they separated, a long filament of material composed of stuff mixed by the collision would drag out between them. The part of this nearest the companion and most nearly sharing its speed would fly away with it, possibly forming eventually one or more planets revolving close to it, and the same would be true for the interloper. But if companion and interloper went off in quite different directions (as is probable) the middle part of the filament would be left with a much smaller motion, relative to the sun, than either of them, and this motion might very easily be too slow to escape the sun's gravitational pull. Part of the filament would then give rise to bodies moving about the sun in permanent orbits. These would all extend to a distance as great as or greater than that of the place of the collision, but the angular momentum per ton would be much greater for some parts of the filament than for others. If it condensed into a number of lumps, the primitive planets then would have very different values of the angular momentum per ton, as the actual planets do. It is entirely possible, nevertheless, that all should circulate around the sun in the same general direction.

The second great obstacle to a rational theory of the origin of the planets has thus been successfully removed.

MOREOVER, Lyttleton's theory without further assumptions removes a third great difficulty; namely, the origin of the satellite systems. These are obviously miniatures of the solar system and we might justly expect that a theory which explained the origin of one would explain the other. The best that could be done on the earlier theories of a close encounter with the sun was to assume that the next time the embryo planets came near the sun, its attraction pulled the satellites out of them. But by this time the planets would have settled down to nearly elliptical orbits, and the argument from angular momentum per ton shows that the distance (SA, Figure 1) must have been about half their present distance—far too great for tidal disruption. On the new theory the orbits of the new-born planets would all pass through, or very near, the point of encounter. Only the differences in their periods would prevent near-collisions at their next returns. Fairly close approaches, sufficient to cause considerable changes in the orbits, should occur repeatedly, and, in the course of time, it is likely that some pair of planets would collide, or barely miss one another, and thus provide satellites for one or both of them. In the satellite systems, the central body has most of the angular momentum and the distances of the attendants, measured in radii of the primary, are much smaller than for the planetary systems, so that the original difficulties are no longer hopeless. Even the retrograde satellite of Neptune may be accounted for as a result of a collision in which the other body passed around Neptune in the opposite sense to the planet's rotation. The relatively enormous size of the moon remains troublesome but certainly no more so than on any earlier theory.

All told, the new suggestion marks a very important advance in the attempt to interpret the past of our system. Difficulties still remain but these are rather of a physical than a dynamical nature, and were common to all the older theories as well. The old fatal troubles which left the would-be student of cosmogony almost in despair are apparently vanquished.—*Jamestown, Rhode Island August 2, 1936.*

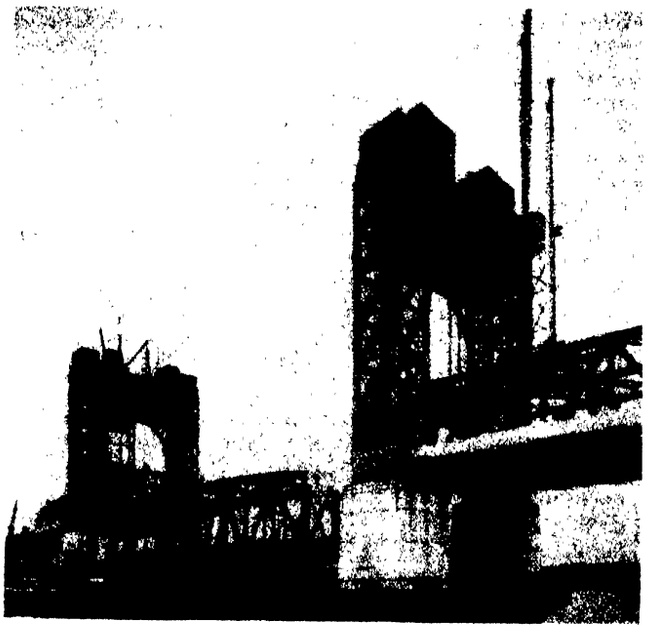
A photograph of Lick Observatory, taken by Oscar S. Marshall, an amateur astronomer of Pasadena, California—one of the founders of the "Telescope Makers of Springfield" (Vermont), an amateur movement which has spread far beyond its origins

Four Bridges

Seven Years Building . . . Unite Three Boroughs . . . Traffic Sorter . . . Part of an Express Highway System

MOTORISTS in the most congested traffic area in the world have recently been able to try out a marvelous piece of engineering designed especially to speed up motor traffic and eliminate congestion. This area is a part of Greater New York, and the engineering marvel is the Triborough Bridge. In order to visualize the scope of the project, it is necessary to keep in mind the fact that New York City is composed of five boroughs, one of which—

The suspension span over Hell Gate, looking from Queens. The main span is 1380 feet long, the side spans 705 feet. Vertical clearance over the river is 135 feet. Width over all is 113 feet, and the towers are 315 feet high. The span is stiffened against wind by trusses 20 feet in depth and a system of bracing below the roadway. The roadway itself will safely accommodate eight lanes of motor car traffic



Hoisting the vertical lift span from car floats on which it was constructed. Massive design of the 210-foot towers is shown in this photograph

Vertical lift span in the Manhattan branch, during construction. The lift span has a length over the channel of 310 feet, is 55 feet above the water in lowered position, and can be raised to provide a clearance of 135 feet. Measured in terms of deck area—29,000 square feet—this is the largest span of its type yet constructed

Manhattan—is situated on an island, and another—Queens—on the western tip of Long Island. Any traffic entering or leaving Manhattan must make use of bridges, tunnels, or ferries. To eliminate many of the traffic difficulties occasioned by this—from the motorist's point of view—unfortunate geographical situation, the Triborough Bridge was conceived. Construction started on October 25, 1929. With a lapse in construction from the spring of 1932 to November 1933, due to lack of funds, the bridge was completed in July 1936. Total cost was 60,300,000 dollars.

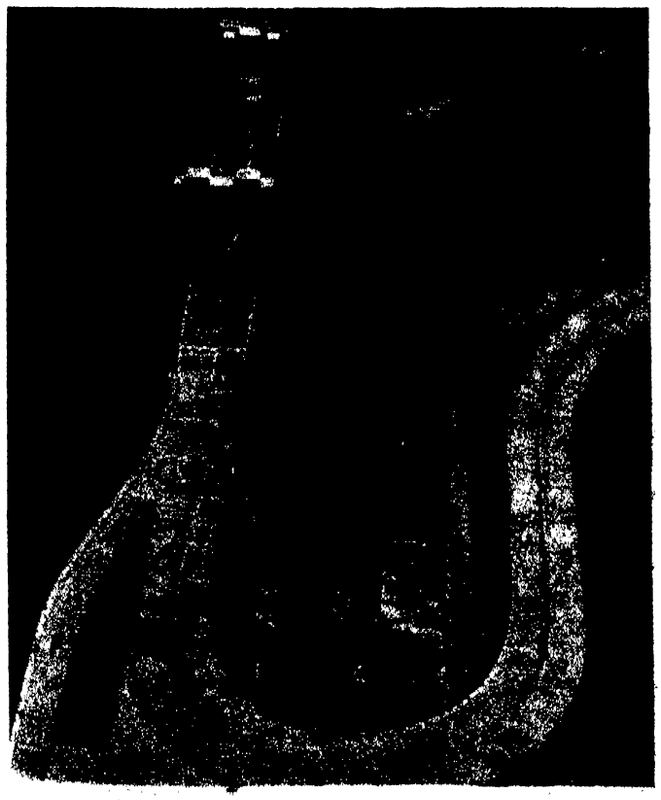
Although this newest of the really great bridges is usually referred to in the singular, it is really composed of four over-water spans, with connecting

In One

links, and a model express highway, totalling 17½ miles in length. The air view directly to the right gives a complete picture (looking east) of the bridge structures and connecting links. In the right foreground is Manhattan; in the left foreground, the Bronx; and in the upper background, Queens. Traffic from Queens is carried first on a suspension bridge over Hell Gate in the East River, thence on a plate girder viaduct structure across Ward's Island, Little Hell Gate, and Randall's Island. On the latter is a traffic-dividing junction with the Manhattan branch of the structure. From the junction, truss spans carry the roadways over the Bronx Kills and a large railroad yard to the Bronx. The design here is such that, if the Kills ever is made navigable, the truss may be converted into a lift span. The Manhattan branch consists of truss spans on Randall's Island and a vertical lift bridge across the Harlem River. The Manhattan approach separates into two branches to carry traffic directly into the streets of the island or to the street grade at the waterfront as shown in the illustration below.

Aerial view of the Triborough Bridge, showing the completed project and some of the approach highways, which, in themselves, constitute a remarkable system for speeding up and by-passing traffic around congested thoroughfares. The traffic divider on Randall's Island (see also our front cover) eliminates all grade crossings, enables traffic to go its way without interference, and permits the collection of tolls with a minimum loss of time

Ramps at the Manhattan end of the bridge. Traffic to and from the interior of the island uses separated ramps; east waterfront traffic makes use of the curved approach shown



Cable spinning operations at the Ward's Island anchorage of the Hell Gate suspension span. Two parallel cables 20¾ inches in diameter, each containing 9176 wires, carry the weight of the span through steel suspender ropes which pass over grooved cable bands spaced 29 feet apart. These suspender ropes are attached to steel floor beams, eight feet deep, which span the full width of the deck of the bridge

Our Merchant Marine To Be

Merchant Marine Act of 1936 . . . Direct Subsidies . . . Helps Development, Shipbuilding . . . Strengthens Competitive Position . . . Aids National Defense

By HON. DANIEL C. ROPER
Secretary of Commerce

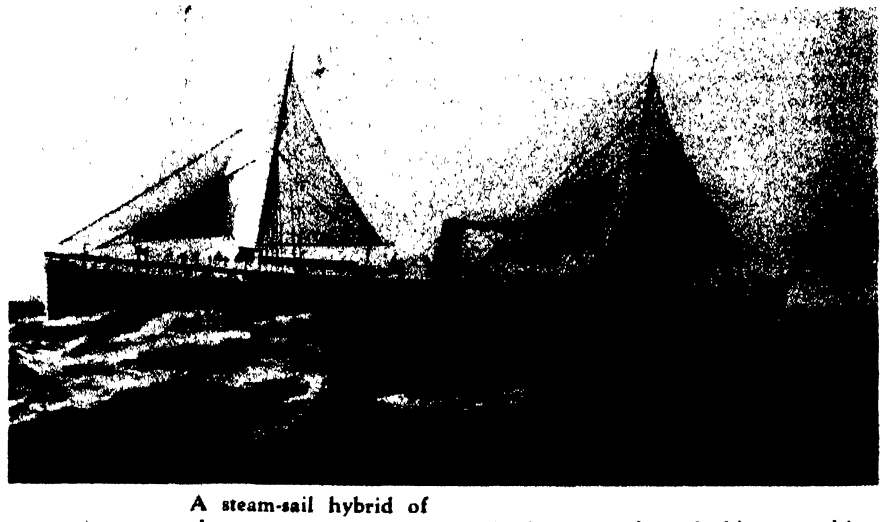
THE day Congress adjourned it enacted a measure which had engaged the attention of Congressional committees for more than a year and which on the statute books will be known as the Merchant Marine Act of 1936. The declared purpose of this Act, the fourth great merchant marine measure to be enacted into law during the past generation, is to further the development and maintenance of an adequate and well-balanced merchant marine under the American flag.

Despite divergent views as to the merits of the bill in the form in which it finally passed both Houses, its enactment brought a feeling of relief to those who realize our weak competitive position on the country's essential trade-routes. New legislation had become absolutely necessary if we were to preserve and improve the maritime position which we have won since the war. It was clear to everyone that the system of indirect subsidies established by the Merchant Marine Act of 1928 had not produced the results expected by its proponents. Not only had it lent itself to certain abuses of administrative power, but it had failed to protect the American taxpayer from the unconscionable practices indulged in by some of the shipowners who were receiving Government aid. Perhaps the outstanding weakness of the Act was its failure to bring about a sufficient number of replacements to modernize a fleet which has become so obsolete that without generous subsidies it can no longer hope to compete in international trade.

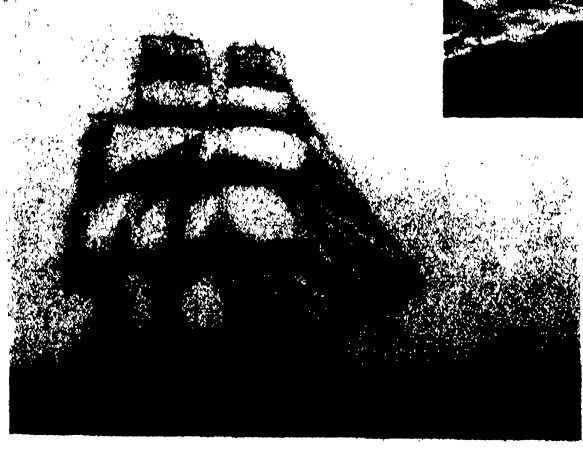
The new law substitutes a system of direct aids for the indirect subsidies now granted in the form of compensation for the carriage of ocean mails. It contains numerous provisions designed to prevent laxity of administration. It places on the shipowner certain definite obligations which were lacking in the old law and which it is felt will adequately safeguard the interests of the Government. Finally—and to me this is the best feature of the new legislation—it will make possible the early and orderly replacement of our antiquated tonnage, including about 200 cargo ships which have already seen their best days and which, because of age, slow speed, and high fuel consumption, are dissipating a large part of the financial aid received by their owners for the maintenance and improvement of essential services. These antiquated cargo vessels, operated at excessive cost, have for years been waging a losing contest on the country's overseas trade-routes, in competition with the newer and more economical ships that have been built since the war by our numerous maritime rivals.

While the high cost of operating obsolete ships is fully realized by naval architects, marine engineers, and, of course, by the individuals who have the misfortune to own them, I believe that it is not so well understood by the public at large. We can draw a graphic parallel by saying that the attempted successful operation of a ship built according to pre-war plans and specifications is a good deal like trying to make money with an auto truck of the vintage of 1914. In both cases there are excessive repair costs, excessive fuel bills, slowness of delivery, and a consequent inability to secure high-grade business. Furthermore, when the ships—or trucks—are slow, a larger fleet is required to transport a given volume of freight than would be the case if the carriers were fast, modern, and economical to operate.

The fact that the United States, due to its large number of old cargo ships, has the most antiquated and non-competitive merchant marine of any of the principal maritime nations, is no reflection on the American shipbuilder. Our possession of this obsolete tonnage results in part from the haste which marked our war-time shipbuilding activities, and in part from our subsequent failure to realize how great a handicap these old vessels impose on the American



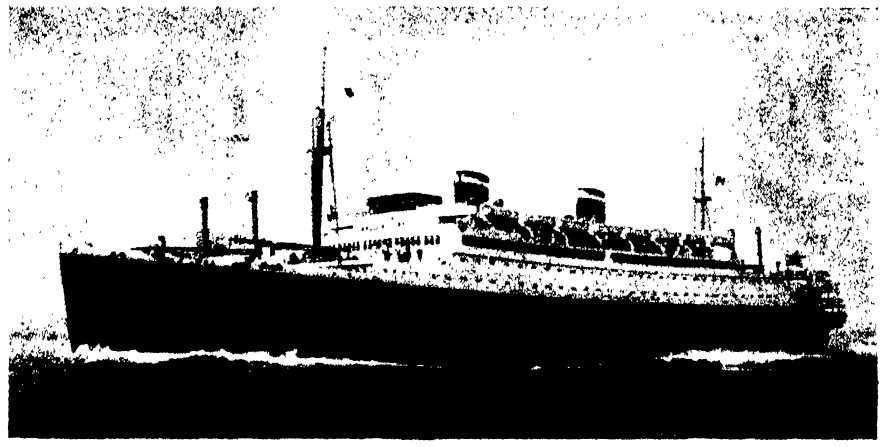
A steam-sail hybrid of the past century, representative of an important transition period



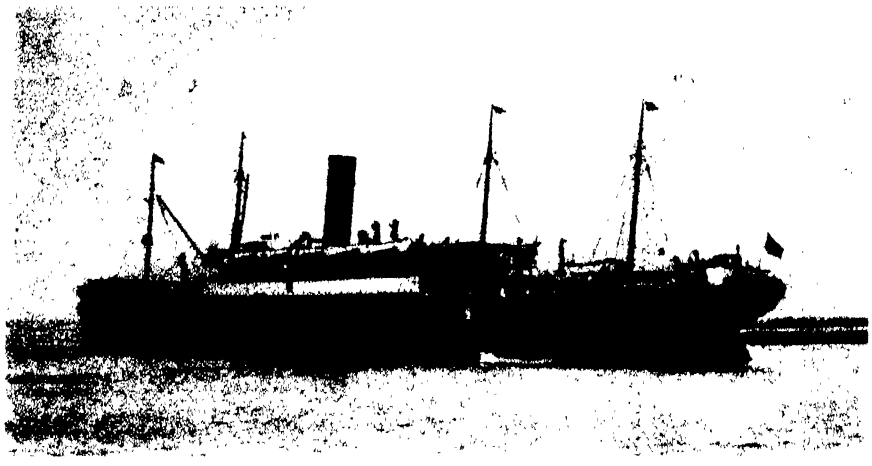
Finer than any sailing vessels ever built elsewhere, the American clippers were world-famous carriers of cargo

shipowner. As a matter of fact, at the time they were built we had little choice as to type, sizes, and speeds. So urgent was the demand for tonnage to replace the losses inflicted upon Allied shipping by the German submarines that instead of designing ships to embody the latest developments in construction and propulsion, we built our large fleet of cargo vessels from already existing plans and specifications. In other words, we saved time by sacrificing modernity, and I am sure that no one can justly blame us for doing so.

The Merchant Marine Act of 1936 provides the ways and means of building new and efficient units to take the place of this emergency construction, much of which was outmoded even when launched. A few figures will help us to realize that the new legislation came not a day too soon—that unless these old ships are speedily replaced with modern tonnage, the United States will stand in imminent danger of losing its position as one of the great maritime nations.



One of the two finest liners of our merchant marine, the *Manhattan*



An American steamer of 1904 vintage, still in use although antiquated

APPROXIMATELY 45 ships of our foreign trade fleet are 20 or more years of age—the period usually held to constitute the life-span of a steel ship. Three hundred and ninety-four more will reach this age within the next six years. Now, while a ship 20 years old may still be in fair physical condition, the fact remains that in this age of rapid mechanical progress there are other factors of obsolescence which must be taken into consideration. Reverting to our parallel of the gasoline truck, we can say that no alert business man would consider the use of trucks built 20 years ago, even if they had never seen a day's service and were just as good as when they left the factory. For the reason that international rivalry in shipbuilding has produced improvements in marine design and equipment analogous to those which have taken place in the automobile industry, I think that we should consider the factor of mechanical obsolescence, as well as that of mere age, in computing the useful life of a ship.

If this suggestion has merit—and the experts tell me that it has—the figures I have just quoted become fairly sinister in their implications. They show that under the new legislation, and with the least possible delay, we should plan and launch a ship-building program designed to replace, within the next few years, a grand total of 439 ocean-going ships, of approximately 2,600,000 gross tons. The magnitude of the undertaking can be realized from the statement that on January 1st of this year our entire foreign trade fleet, counting vessels of 2000 gross tons and over, totaled 485 ships, of 3,037,000 gross tons. In other words, with the exception of 46 ships, the greater number of which were built under the provisions of the Merchant Marine Act of 1928, every American vessel now engaged in overseas foreign trade will within the next six years be 20 or more years of age, and therefore well beyond the dead-line of complete obsolescence if we compute the dead-line on the basis of operating efficiency and economy.

Now that new legislation has been enacted, I have every confidence that the replacement of our old ships by modern competitive tonnage will be undertaken with the same dash and enterprise invariably displayed by our people when faced with a real emergency. Have we the shipbuilding talent and facilities necessary to insure the success of a program of this magnitude—a program which, when completed, will be outranked only by our achievements in this line during and immediately after the war? Let us glance for a moment at the long and illustrious record of the American shipbuilder, which extends over a period of more than three centuries.

Our shipbuilding activities during the Colonial Period and during the clipper ship era is a story which I need not dwell upon here. It will suffice to say that no finer sailing ships than the fast American clippers were ever built anywhere. During the early Nineteenth Century, American shipbuilders were pioneers in the development of mechanical propulsion, and in the period preceding the Civil War they led the world in the use of steam as the motive power of ships. It is true that after the war, absorbed as we were in the country's internal rehabilitation and development, we became so dilatory and apathetic in our attitude toward everything maritime that it was not until 1893 that our steam tonnage exceeded our tonnage under sail. Great Britain's mercantile marine had passed this crucial point five years earlier.

BY 1914, two of our best equipped shipyards were preparing to go out of business, owing to a dearth of work, when a veritable deluge of orders was precipitated by the outbreak of hostilities in Europe. At the time of our entrance into the war there were but 61 shipyards, with 235 launching ways, in the entire country. Eighteen months later, when hostilities ended, the number of shipyards had been increased to 341, with more than 1200 launching ways. At the peak of production we had a force of shipyard workers exceeding in number all the inhabitants of Wyoming, Nevada, and Alaska combined. We built 2316 vessels, of more than 13,000,000 deadweight tons—enough to line both sides of the highway from Washington to Baltimore, and among them were the fabricated cargo ships al-

Air view of an American shipyard equipped to build fine ships

ready referred to. The world had never seen anything like it.

Another lull ensued, and it was not until the Merchant Marine Act of 1928 was placed on the statute books that the American shipbuilder was given another opportunity to show what he could do in the way of building merchant vessels. This time the disturbing factor of haste which characterized the feverish war construction program was absent. Since there was no call for volume production, each ship could be planned for its particular trade-route requirements. As a result, the 33 splendid combination passenger and freight ships built under the provisions of the Act of 1928 are the equals, in workmanship and operating efficiency, of any vessels of comparable types, sizes, and speeds that the best foreign yards have ever produced. The fact that most of these vessels have managed to show an operating profit, even in the face of depressed conditions in international trade, constitutes the strongest kind of an argument for a replacement program that will give us a modern fleet.

OUTSTANDING among these new ships are the two largest merchantmen ever built in the United States—the well-known liners *Manhattan* and *Washington*. If present plans do not miscarry, a third vessel of approximately the same type, size, and speed will be built in the near future. I mention these vessels not because of their deserved popularity, but in order to correct an impression that they represent the ultimate achievement of which our naval architects, marine engineers, and shipbuilders are capable. The idea seems to prevail that because they are less than one-third the size of the *Normandie* and *Queen Mary*, the United States lacks the talent to build real superliners. That there is no justification whatever for such reasoning is shown by the fact that about 10 years ago—antedating any of the popular liners of today—two superships were launched in the United States that can still match (and perhaps exceed) the speed of any foreign superliner, while in propelling power they exceed all but one. The American ships referred to are the airplane carriers *Lexington* and *Saratoga*. These two great ships of the United States Navy show what our marine architects, engineers, and designers can do.

Prediction is always hazardous, and I would be loath to say that superliners will never be built in the United States. There are two schools of thought on the subject and both have persuasive arguments. The adherents of one school justify the huge expense and the element of financial risk which are always present in such undertakings on the ground of national prestige and national defense. The other school takes the prosaic stand that ships of smaller size are likely to prove better investments. While I have an open mind on the subject, I cannot lose sight of the fact that for the cost of one superliner we could build a large fleet of cargo liners of the most approved design, and after all these cargo liners are the real backbone of the merchant marine. It would seem the part of wisdom to take care of our essential requirements before we go in for costly luxuries.

I have been at some pains to show that what the American Merchant Marine needs above all else is a comprehensive replacement program. Considerable planning along this line has already been done—in outline, if not in detail—and I am sure that the United States has the technical talent to put the plans into effect, now that the necessary legislation has been enacted.

The new vessels to be built under the Merchant Marine Act of 1936 will embody all the safety devices required by the respective types of ships. Passenger vessels will be planned to incorporate the most approved safety features which modern science has devised, with especial reference to compartmentation, stability, fire-resisting materials, fire-fighting equipment, and life-saving appliances. American naval architects and marine engineers, the peers of any in the world, may be counted upon to plan ships every whit as safe as the best productions of our maritime competitors. In this connection it might be well to point out that according to a comparative table recently issued by Lloyd's, the British classification society, the United States and Sweden tied for lowest place in the ratio of vessel losses to total tonnage during 1934 and the first half of 1935. This showing, it seems to me, goes far to refute the unjust criticisms which from time to time have been levelled against the safety of American merchant ships.

THE Merchant Marine Act of 1936, a compromise measure, is by no means a perfect piece of legislation. There is comfort in the thought, however, that any defects, omissions, or ambiguities which may develop under trial can be corrected by legislative amendment at future sessions of Congress. The strong point in the basic philosophy of the Act is what I may call its double-barreled insistence that no matter what happens the United States is at long last going to have an adequate merchant marine.

I take it as a happy augury that the Merchant Marine Act of 1936 becomes effective at a time when we are rapidly emerging from the depression. If wisely administered, it should give us, within the next few years, a strong and adequate merchant marine, capable of competing successfully with the ships of any nation, and of meeting the requirements of an expanded Navy in time of national peril. Moreover, the contemplated shipbuilding program will stimulate activity in the heavy industries, furnish maximum employment for American shipyards, and thus prove a contributing factor in stabilizing national recovery.

The Commission or Authority provided for the administration of this Act is probably the most important that will be appointed in this decade. Its personnel needs to be of the highest citizenship caliber obtainable. It must be free of political control, free of group or interest control; men of tested and proved integrity, of national vision and capable of thinking for and acting for our entire people and nation.

By Margaret Bourke White, courtesy TWA

Sky City of Acoma, New Mexico, said to be the oldest continuously inhabited Indian village in America

AMERICA FROM THE AIR

THE conquests of centuries, the geographical marks left by each succeeding wave of American pioneers, pass in majestic array beneath the fuselage of your swift air-transport plane, as you cross the American continent after leaving your breakfast table on the Atlantic only to seat yourself for late supper the same day on Pacific shores. As sky travelers pass high above places of scenic and historic interest, the many legends which forever attach themselves to chapters of American history become less obscure. At the end of a flight over the transcontinental airways, one is able to speak intelligently of the Enchanted Mesa, the Sky City of Acoma, Meteor Crater, Inspiration Rock, the Grand Canyon, and scores of other historic locations of scenic grandeur.

In less than 16 hours a half-hundred anecdotes of history come out of the past and refresh your memory as the co-pilot in his friendly conversation describes the ever-changing panorama below you. Even if you fly at night, and the clusters of lights which slip by below mark some city or town, there comes to mind the tortuous journeys completed by wagon-train to found these various cities years ago; perhaps the co-pilot will tell you that in the last half-hour's flight you have covered a distance which would have required three weeks by covered wagon.

THIS age-old trail followed by skyliners has been marked by the bleached bones of those who succumbed to its devastating thirst, has felt the crunch of iron-bound wagon wheels, the drive of pounding pistons, the plodding of sandaled feet, and now, far above it, is heard the whirr of glistening propellers.

No other mode of transportation can give to the traveler such an understanding of this country's magnitude. In traveling from Atlantic shores to the Pacific with the sun's shadow, the sky traveler can see approximately 20 percent of the total number of square miles within the United States on this one trip. With perfect visibility at 8000 feet, the horizon appears 118 miles distant, giving a visible area of 236 miles by 2567, making a total of 605,812 square miles of scenery.

Night flying, especially in moonlight, can only be likened to standing by the rail of a sleek ocean liner as it plows its way through moonbeams reflected on dark water. A peculiar light filters over the landscape below and, contrary to popular opinion, it is easy to note various ground formations and see quite a distance to the right and left of the plane's course.

Cities and towns take on a different personality at night, each having its distinctive formation of boundaries marked by lights and shadows. Los Angeles is acclaimed by air travelers to be the most dazzling approach in darkness. Then come Chicago and New York. The clear atmosphere of the Pacific Coast lends an enchanting aurora to a myriad of lights set like jewels against a background of velvet.

SCIENCE VERSUS MAGIC

Oil Prospecting by Physics . . . Will Average Oil Strikes Nine Times out of Ten . . . Using a Simple Pendulum . . . Incredible, Uncanny Sensitivity

By AUBREY D. McFADYEN

ALL over the world small bands of scientists are "playing doodle-bug in the face of mother-earth," as the natives jestingly describe their work. These scientists so quickly and quietly carry out their mission in a community that their presence is scarcely noticed. They operate alike over valuable and worthless lands, over mountainous and coastal regions, even out to sea. Their mission is to search for deposits of oil—the life-blood of modern civilization.

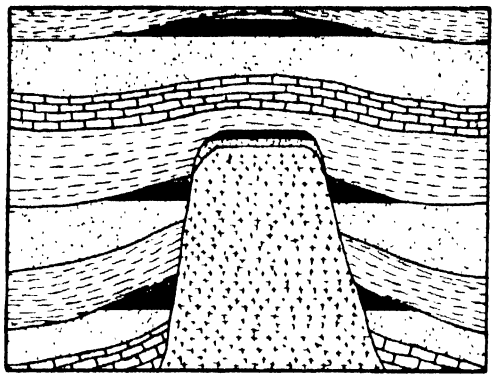


Figure 1: **A cross-section of a typical salt dome. The "sands" (dotted areas) are topped by oil reservoirs around the dome**

As between nations, war may be waged to guarantee an ample oil supply. But as between rival oil companies, seeking reserves to meet the future needs of their patrons, a war of friendly, though keen, competition is being waged constantly. The strategy of this war has resolved itself into a contest to discover and explore new oil sources. The battles of the major oil companies are being fought by the geophysical explorer.

The procedure followed by the geophysical explorer at first blush appears like Black Magic in its darkest form. Yet a little investigation into the work of these scientists reveals that their practice is based upon some of the simplest things of every-day life, operating under elementary principles of physics known to every school boy. Ordinary clock pendulums of great accuracy comprise the wands which divine the location of oil reservoirs. The principle of sound echoes is relied upon to measure the depth of the oil-bearing formation below the surface of the earth.

Oil, geologists tell us, is derived from animal and plant remains. In ages past this organic matter became embedded in porous layers of sediment which make up portions of the earth's crust. Later it was decomposed, yielding petroleum. This explanation is verified by the fact that oil occurs in all the fossil-bearing layers of the earth. Oil never occurs in paying quantities, however, unless there is a porous stratum overlain by an impervious stratum which blankets or seals the oil against evaporation.

If the make-up of the earth's crust were exactly uniform, there would be an even distribution of oil throughout the areas of the earth where plant and animal life either had flourished or been deposited. But the earth's crust has formations which provide reservoirs into which the oil has collected and remains stored. Since the oil globules originate in a porous stratum, they have a tendency to move along that stratum, when and if it is at all inclined, combining with other globules enroute. If the stratum is one which bears water, the oil, being lighter, will float ahead to the peak of the stratum, where it will be concentrated; that is, provided the stratum does not reach the surface, in which case the oil will have escaped long since by evaporation.

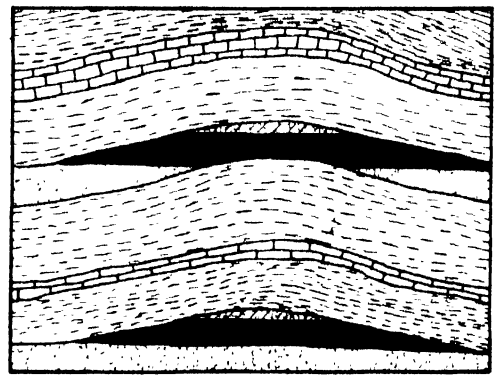


Figure 2: **Cross-section of a typical oil and gas bearing anticline. Oil (black) and gas (diagonal lines) are shown in rocks on top of the "sand" or sandstone (dotted)**

It cannot be told in advance that oil is present in the reservoir formation. The oil may have escaped in ages past; it may have migrated during some remote period when the inclination of the porous stratum was different; or it may never have been there, due to absence of plant or animal life in that area. At most, the geophysicist can locate only a subterranean formation of the kind which experience teaches to be a likely storage place for oil. Geophysicists offer no fixed formulas for discovering oil. In the last analysis it is the drill which actually finds oil. However, a skilled exploration party, working in a favorable region, will average strikes in nine out of ten forecasts.

The most productive oil fields today are in the Gulf Coast area, and these fields present a peculiar, though familiar, geological picture—the salt dome formation. Huge plugs of almost pure salt are pushed up from the "floor" of the earth (Figure 1). These salt plugs measure from one-half mile to four or five miles in diameter, and are believed to extend as far as 20,000 to 30,000 feet into the earth. In pushing their way up, the salt plugs have broken through porous layers of the earth's crust, bending them up to an angle such that reservoirs for oil are provided

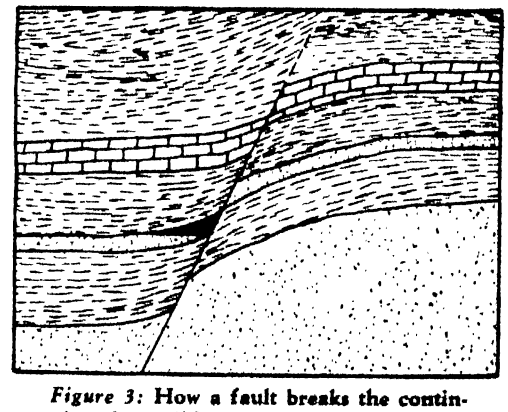


Figure 3: **How a fault breaks the continuity of an oil-bearing sand, seals the end of the stratum and permits oil gradually to accumulate there—if the seal is tight**

along the flanks of the plug, as well as on top of it. Later, the oil contained in the distorted layers has moved into these reservoirs, the crest of the plug usually providing a vast dome filled with oil.

Assuming, as the oil men know from experience, that these salt plugs are capped with oil, how would one proceed to locate the salt plug?

The story begins in 1583 when the great physicist Galileo, according to tradition, was distracted from his worship in the Cathedral at Pisa by a chandelier swinging from the ceiling. Its regular rhythm caused Galileo to check the period of its swinging with reference to his pulse beat. From this beginning Galileo brought forth the modern pendulum, and developed its laws. First of all, Galileo made it plain that a pendulum swings by reason of "gravity" or pull of the earth upon it.

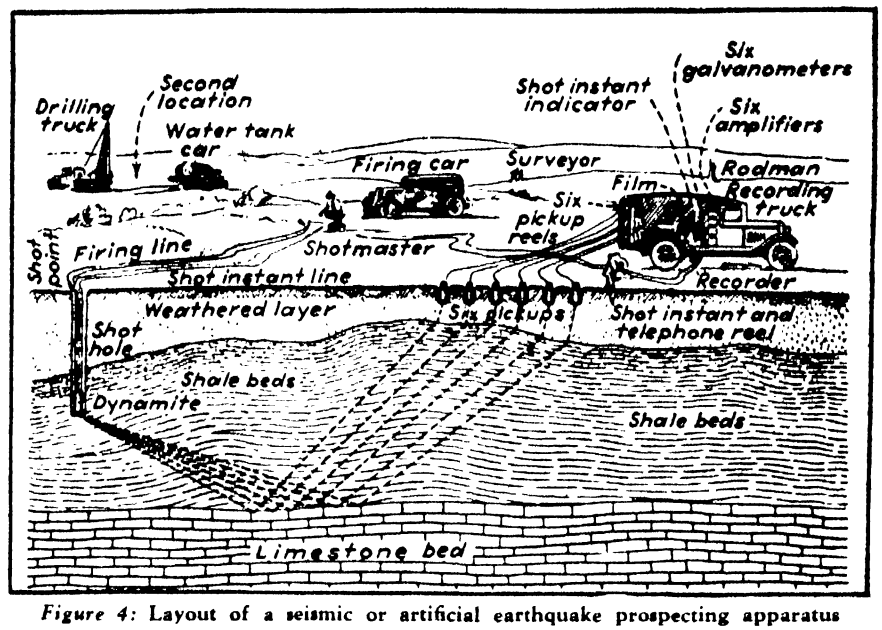


Figure 4: Layout of a seismic or artificial earthquake prospecting apparatus

HUYGHENS, a Dutchman, being impressed by the extreme regularity of the period of oscillation of the pendulum, put it to use as a time-piece. Later Huyghens' pendulum clocks covered the globe.

It was known as early as 1671 that a pendulum clock loses time upon being moved toward the equator, since the centrifugal force of the earth's rotation increases as the equator is approached. It also became known generally that pendulum clocks lose time when carried from one place to another place of higher elevation; for example, if carried to the top of a mountain. When placed upon a mountain the pendulum is slightly removed from the bulk of matter constituting the earth, whereby the pull of the earth upon the pendulum is diminished, resulting in its period lagging, with consequent inaccuracy of the clock. It would be "slow." It was later discovered that pendulum clocks also vary in time if moved over different portions of flat land. Why? Men of science explained that this is due to variations in the pull of the earth at these several places, because of non-uniformity in the make-up of the earth's crust beneath. For centuries these facts were known. It remained for a new type of experimenters, led by Dr. E. E. DeGolyer, to put these facts and principles into practical use.

These huge bodies of salt, they reasoned, being lighter than average areas of the earth, should lessen the pull of gravity of the vicinity where present. Obviously the variation in the pull of the earth due to the salt plug will be very slight, probably not over four or five ten-millionths from its normal value, but there should be a difference. But what could measure so small a force? They concluded that, if a pendulum be placed over or adjacent to a salt dome, it should run "slow." After several hours it should be possible to detect the effect of the salt plug upon the period of its swing.

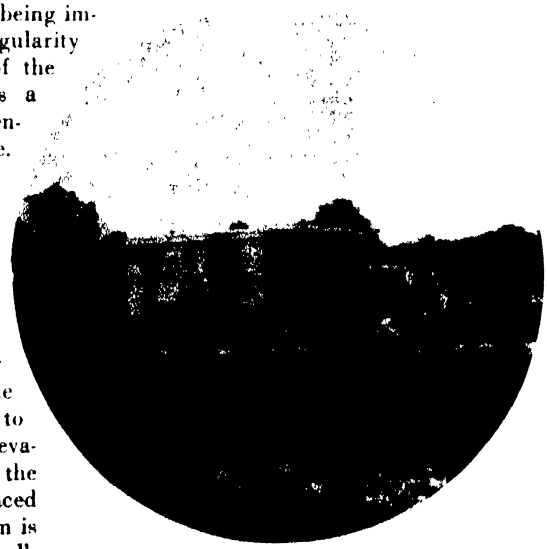


Figure 5: A seismic prospecting operator's field truck carrying the recorders

Tests demonstrated the truth of this reasoning. There was found to be enough salt in the average salt plug to vary the pull of gravity as much as 20 to 50 ten-millionths from its normal reading (980 dynes). By comparing the pendulum readings at points spaced two or three miles apart along a selected course, it was found possible to chart accurately the sub-surface formations. The world was thus taught how to strike a salt dome "right on the nose."

The work of Dr. Harvey C. Hayes of the United States Geodetic Survey went far toward bringing the pendulum method of geophysical exploration to its present high efficiency. In practicing the Hayes pendulum method, a string of exactly matched field pendulums is set up, with the individual pendulums two to five miles apart along a course to be explored. Each field pendulum station is equipped with a radio set for automatically sending a signal to the base station upon each swing of its pendulum. At a prescribed time all the pendulums in the expedition are cocked, whereupon a radio signal from the base station simultaneously releases all for swinging movement. Each swing of each field pendulum is flashed back to the base station, where the progress of the entire set of pendulums is recorded automatically in parallel lines upon a photographic strip. At the end of two hours, or thereabouts, the relative positions of the pendulums may be compared by drawing a line through the points on the record strip indicating the position of each pendulum. This line indicates the geological picture of the area below.

IF a pendulum is to be useful in geophysical exploration, its period must be known to within one one-hundred-millionth of a second. This extreme accuracy of pendulums is necessary because the set-up must be sensitive to a departure of two ten-millionths from the normal pull of gravity.

The pendulum method is not restricted to finding salt domes. It is effective for locating the crest of "anticlines" of all types. An anticline (Figure 2) is nothing more than an arched upward bulge or upfold of the earth's crust. The most common form is where the sub-stratum takes a wave formation, oil sometimes being entrapped under the crests of the waves. This formation is quite commonly encountered in nearly all sections of the world, but the mere presence of an anticline does not give assurance that oil lies under its fold.

In another type called "fault forma-

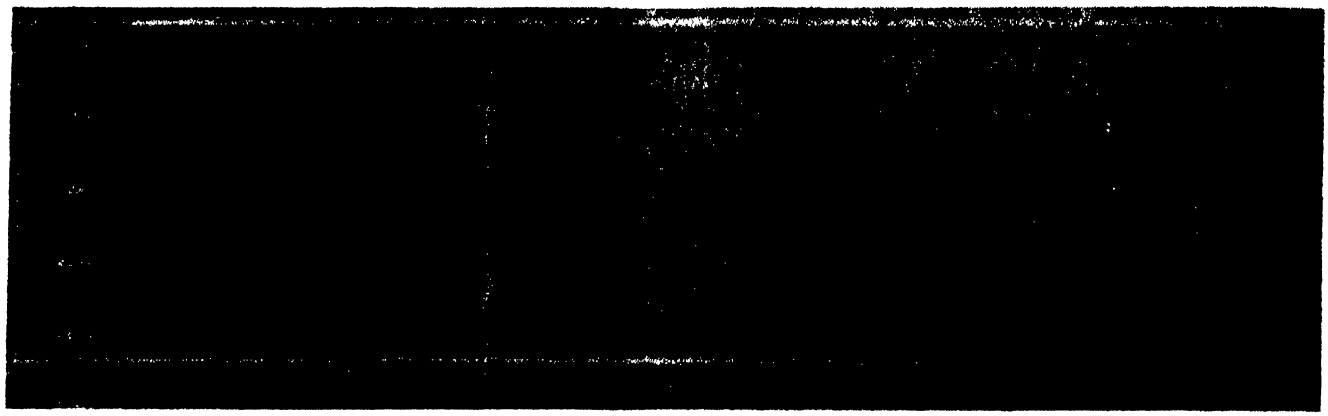


Figure 6: **An actual oscillograph record of a seismic shot in the field**

tions" the strata have become sheared, with the strata at one side of the shear being pushed up and sometimes forming a pocket (Figure 3). These are quite common in the Oklahoma area and about the California coast, and in these regions usually provide excellent oil reservoirs.

In every case where the denser, impervious stratum of rock which blankets in the oil rises toward the surface, the period of oscillation of the pendulum will be accelerated by it. In this way the high point of the anticline may be detected, whether it be the crest of a wave formation or the rocks at one side of a fault.

THE crowning achievement in geophysical research is the modern seismic prospecting set-up. For this, again, the world is primarily indebted to the genius of Dr. DeGolyer, who took the crude apparatus developed in Germany and developed it to its present efficiency.

In this set-up (Figures 4, 5) a charge of dynamite is exploded electrically, and the impulse or shock thereby given to the earth travels downward until it hits a reflecting layer. At this layer the seismic wave is reflected toward the surface, where its presence is recorded by several vibration detectors. Each detector is a specially constructed instrument which converts the mechanical vibration of the ground into electrical impulses. These impulses are amplified and recorded in parallel lines on a moving strip of photographic paper, making an oscillograph record (Figure 6). On the same sheet of paper are also recorded the electrical impulses which detonated the dynamite, and a series of timing marks at equally spaced intervals of one hundredth of a second.

If the time of travel of the seismic wave through the earth is known, it is possible to calculate the depth of the reflecting layer simply by measuring the time between the blast and the arrival of the reflected shock at the vibration recorder. The seismic wave may be regarded as a sound wave traveling through the earth's surface, and the arrival of the reflected wave as an echo. The accuracy involved in determining the depth of the reflecting layer may be as good as one-tenth of one percent under favorable conditions.

The seismic method *does not find oil, as such,* any more than does the pendulum method. The reflecting layer gives no clue that will indicate the presence of minerals or other valuable sub-surface deposits. It indicates only the depth of the layers of the earth, or that there is a distinct discontinuity of shape in the geology of the region, which is of prime importance in the geologic study of any prospecting survey.

The seismic apparatus is now used extensively in conjunction with the pendulum set-up to check the depth below the surface of the layers of stratum or salt bodies picked up by the pendulum test.

The incredible sensitivity of the seismic pick-up can be appreciated only after witnessing its performance in the field. As a preliminary check upon the apparatus, a member of the crew steps off 500 paces, and taps the earth lightly with his foot. The little recording pen must trace in exact response to his tapping.

Figure 7: **Returning after taking a field reading on a torsion balance**

"We dig a hole about a yard deep, to get a firm footing for the seismic unit," one geophysical prospector stated. "These seismic detectors, although of a light, portable type, will sense incredibly small tremors of the earth. For instance, we shave off all grass about the spot, for even its quivering in a breeze will be picked up by the instruments. The wind frequently upsets our apple-cart. We find it necessary to fill the hole above the instrument level with the surface of the ground, to avoid air concussions caused by gusts of wind."

"During the test," he continued, "every one must remain absolutely still. Even to shift your weight from one foot to the other might affect the readings given by the instruments. That is why we first drive all cattle, rabbits, and the like from the vicinity we are checking."

In a few minutes the geophysicist is scrutinizing a jagged line which the seismic apparatus has picked up and the recorder put in permanent form. What does the jagged line say? To read it would appear to an outsider somewhat like trying to decipher by sight the melody cut in the sound groove of a phonograph record. But this man has a trained eye. For years he has been decoding such signals. A smile spreads over his face. "The peak of the subsurface incline is right there," he points out. "The formation breaks sharply and appears to present a nice receptacle.

Figure 8: **Hut for a torsion balance, to diminish effects of wind**

Probably it is filled with valuable oil."

The present trend in gravitational instruments is toward a single unit structure, which is both simple and accurate, while designed to give absolute readings. These new gravity meters are transported in succession to the several spots where the pendulum stations are ordinarily located. Since they give an absolute reading, the expense and trouble of

Figure 9: Dr. Ludwig W. Blau, formerly a Texas professor of physics

comparison with a standard, as for instance the pendulum base station, is eliminated.

In the early stages of development, gravity meters took the form of the "torsion balance" as designed by Eötvös. It was as late as 1923 that Dr. DeGolyer brought the first torsion balance to the United States from Hungary.

A TORSION balance (Figure 7) consists of a pendant wire upon the free end of which is carried a cross-rod, the cross-rod in turn carrying at either end a weight. The weights are exactly equal, so that the cross-rod is normally in balance. One of the weights, however, is hung from the rod, thereby bringing it closer the earth than the other. The pull of gravity acting on the two weights, the one being nearer the earth than the other, is resolved into a twisting, or torsion of the wire. The degree to which the balance rotates and twists the wire is an index of the pull of gravity of the terrain under test. The torsion balance is of uncanny sensitivity, being affected by a variation of one ten-millionth of a dyne. Two pages back it was mentioned that the normal force of gravity is 980 dynes. Hence the sensitivity of the balance is about one part in 10,000,000,000.

More recent types of gravitometers take the form of small, easily portable units. One comprises a small body suspended by a piezo-electric crystal to the influence of gravity. Delicate electrical means in circuit with the crystal measures any variations in the earth's pull upon said body. Another and extremely simple device is nothing but a glorified capillary tube. The height to which the fluid will rise in the capillary varies with variations in the pull of gravity.

In working the "serpentine" formations about Austin, Texas, the apparatus so far discussed encounters a strange rival. Curiously enough, this formation generally presents "serpentine plugs," so-called, which have been pushed up from below quite similarly to the salt plugs. These plugs contain much of the mineral "magnetite," an iron ore which may be readily detected by means of a delicate magnet. The principle is simple. As the crest of each plug reaches nearer the surface of the earth, the influence of the magnetite therein upon the instrument increases. Geophysicists now have a special magnetic device called a "magnetometer" for this use. It has remarkable sensitivity. The geophysical explorer must first see to it that no magnetic material whatsoever is about his person. The presence of a key in his pocket, or so much as a steel pin, or a single iron tack in his shoe, might introduce disastrous error into the forecast.

Strangely, two nations that yield but small quantities of oil have been forerunners in the study and development of apparatus for charting the structure of the earth's crust. These nations are Germany and Japan. Germany has been motivated by an interest in pure science and the hope of discovering oil or mineral deposits. Japan presents an entirely different story. Frequent earthquakes, with resultant destruction of property, brought the Japanese nation face to face with the need for earthquake prediction. Under Dr. Kyoji Suyehiro, director of the Earthquake Research Institute of Japan, maps of the entire sub-surface of Japan are being made, showing precisely which sections of the earth's crust are most subject to quakes. The same kind of instruments, as devised by the Japanese for use in locating earthquake areas, are equally adapted for use in locating oil wells. In each case the same information is sought—the nature of the earth's "floor."

Although authentic reports indicate an available oil supply sufficient to care for our own nation for about 25 years, the oil companies do not cease their vigilant search for new fields. The major oil companies allot millions of dollars annually for geophysical explorations. Even small concerns keep as many as 20 exploration parties in the field. The investment of oil companies in service stations seems to indicate their conviction that they are in the business permanently.

"I HAVE revised and expanded my estimate of the available oil supply so many times," says Dr. Ludwig W. Blau, Chief of Geophysical Research of the Humble Oil Company (Figure 9), "that now I will not even venture a guess. We have shot over the same areas of the Gulf Coast three times, and on each occasion we have located new wells. This is due to the great improvements in our instruments, also because we can now drill to depths heretofore undreamed of. First we reached the shallow, piercement domes alone. Now we are picking up the deep-seated ones, which seem to offer a new source of production. The day of working wells at depths of 10,000 to 14,000 feet has arrived."

Eleven more or less official forecasts of our oil reserve have been made in the past 20 years, each succeeding estimate being higher than the one before. If the 1920 estimate on recoverable oil remaining in the fields of the United States had been correct, automobiles today would be rusting by the roadside, and men formerly employed in the petroleum industry would be seeking jobs in other fields. It is the work of the small bands of geophysical explorers, even though it appears that they are just "playing doodle-bug," that forestalls our facing such an event as an actuality.

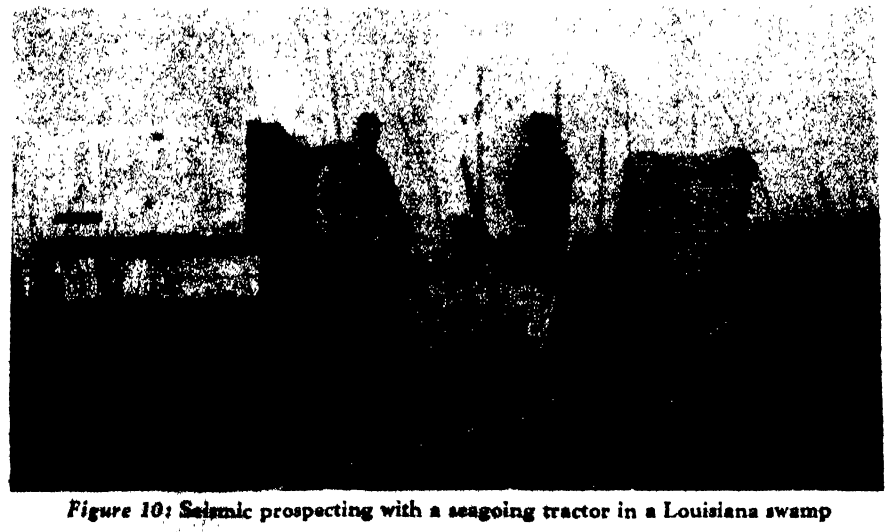


Figure 10: Seismic prospecting with a seagoing tractor in a Louisiana swamp

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
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Chemical Engineer

Stopping Humming Birds' Wings

A REMARKABLE one-hundred-thousandth-of-a-second stop-motion photograph of female ruby-throated humming birds hovering about vials of sweetened liquid is reproduced on this page. Professor Harold E. Edgerton, Kenneth J. Germeshausen, and Herbert E. Grier of the Massachusetts Institute of Technology, where this high-speed method of photography was developed, found that, in hovering, the wings move at the amazing speed of nearly 60 beats a second. Although perches are provided, the birds prefer to hover while feeding. This photograph, probably the first of its kind showing the wing action of the humming bird, was made at the home of Mrs. Laurence J. Webster at Holderness, New Hampshire, where Mrs. Webster, founder of the New Hampshire Nature Camp, has devoted years to the study of wild bird life. These tiny visitors are so tame they take food from Mrs. Webster's lips and perch on her head and shoulders while awaiting their turn to feed.

Humming birds hovering

Gasoline from Gas

CRACKING heavy oil to increase the output of gasoline from crude oil results in splitting large molecules of the oil into smaller ones. Some of these split molecules are the right size for gasoline but others are too small and have been used as gaseous fuels in place of liquid gasoline. Several methods have been suggested for "reforming" these fragments of molecules into the larger ones of liquid gasoline. Recent investigations by Ipatieff and Corson of the Universal Oil Products Company have shown that it is possible by the use of phosphoric acid as a catalyst to convert more than 70 percent of ethylene into liquid fuel. They have further found that the "reformed" gasoline from ethylene (one of the plentiful gases produced in cracking) has an unusually high octane rating so that it is especially valuable in modern motors.—*D. H. K.*

KING COTTON

COTTON still holds its position of importance in the textile fiber field. This is mainly due to its numerous industrial uses. For example, more than half a million bales were used in automobile tires in 1935.

Pneumonia Today

FORTY years ago there was an attitude of absolute pessimism on the part of the medical profession and public health workers regarding pneumonia. Doctor Osler then said that pneumonia was a self-limiting disease for which nothing could be done to abort or prevent. A similar more or less hopeless attitude has persisted until recent years, during which new and hopeful additions have been made to our knowledge of pneumonia.

One of the new principles which has been evolved is the recognition of the fact that pneumonia is not a single disease, but a group of diseases. When we use the term "pneumonia" we are about at the same stage as we were 50 years ago when "enteric fever" and "inflammation of the bowels" were common terms. The recognition that pneumonia is not one, but a group of diseases has been one of the most important factors in developing present-day methods for its control.—*Health News*, bulletin of the New York State Department of Health.

Mending

MENDING woods—those plastic, putty-like mixtures of wood flour and a bonding agent—have been with us for some years and many uses have been found for them. They are particularly valuable in the home or factory workshop for woodwork, furniture repair, and so on.

Four well-known companies—the Sherwin-Williams Company, Premier Chemical Corporation, Detroit White Lead Works, and Acme White Lead and Color Works—have recently developed and put on the market new mending woods in which the bonding agent is a Bakelite resinoid. This base is said to provide superior bonding strength and has many other advantages. The resinoid makes the wood, after hardening, impervious to common acids and alkalies, water and gases. All four of these companies package their mending woods in both cans and collapsible tubes.

Longest Rails Ever Laid

CONTINUOUS welded rails, 4000 feet long, the longest ever laid on a railroad system in one piece, are shown in our illustration as they were prepared for

Four thousand feet to the other end

laying in the Blossburg tunnel of the Northern Pacific Railway's main line through the summit of the Rockies just west of Helena, Montana. The rails were welded together aboard 90 gondola cars from which the ends had been removed. The picture shows them on the cars.

Journals served as rollers underneath the continuous rails and facilitated unloading which was accomplished by parting the train in the middle and pulling half the cars at a time out from under the rails, permitting them to settle to the track. Each continuous rail weighed 85 tons. Similar continuous rails were laid recently in the 4000-foot Bozeman tunnel of the Northern Pacific between Livingston and Bozeman, Montana.

Speed and thrills are assured on this new dirt-surfaced road-racing track

EXPLOSIVES

DURING the first six months of 1936, 30,249,819 more pounds of industrial explosives were used in the United States than in the corresponding period of the year before. Mining, construction enterprises, and quarries used most of these explosives, but farmers used more than the preceding year for ditch blasting, tree planting, and so on.

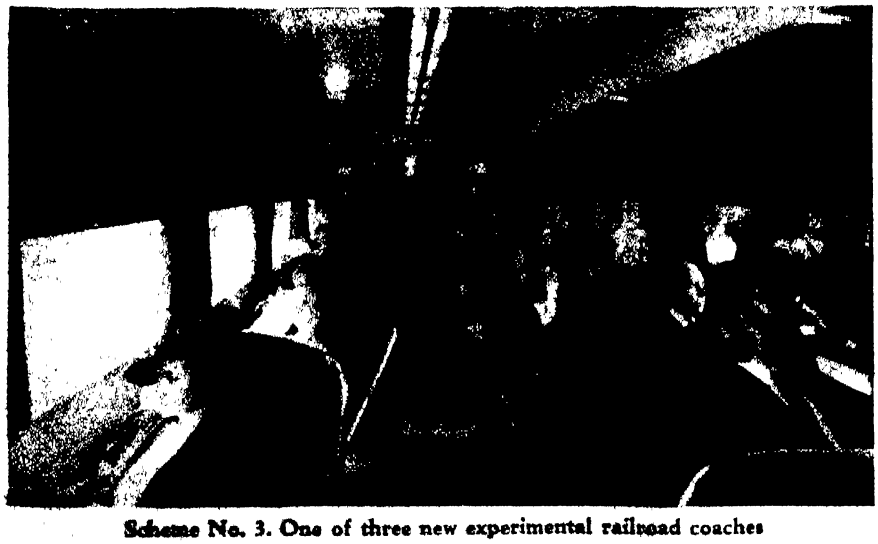
A Railroad Experiments

THREE new experimental types of passenger coaches, representing highly modernized features of interior arrangement and design, and all completely air-conditioned, have been produced by the Pennsylvania Railroad and are now being operated in test service between New York, Philadelphia, Baltimore, and Washington. The principal object of the trial runs, which will later be extended to other sections of the railroad, is to ascertain the reactions of the public to the new features of comfort and convenience embodied in these cars.

Experimental car No. 3525, known as Scheme No. 1, provides seating capacity for 60 passengers. It embraces new double seats, revolving so that any pair may be placed facing in the normal crosswise position, outward facing the windows, or inward facing the aisle.

Experimental car No. 3521, Scheme No. 2, also has a capacity of 60 passengers. The double revolving seats, built on stainless steel frames, provide an entirely new feature in the form of folding trays fitting into the backs which may be used by the passengers at the rear of any pair of seats for writing or game playing, or for the serving of coach lunches. The cars are constructed with long flush windows having no projecting sills or frames and each consists of a single pane of glass 2 feet 8 inches by 5 feet 2 inches, giving an extremely broad and inviting range of vision.

Experimental car No. 1735, Scheme No. 3, is intended primarily for use in long-distance overnight service. It accommodates 42 passengers in 14 double seats on one side and an equal number of single seats on the other. The seats are all of extra width, all revolve and all are made to recline in three positions at the touch of a button. This car is equipped with extra large toilet and wash-rooms in the center. In the air-conditioning equipment of this car the cooled air enters through a decorative duct in the ceiling which distributes it evenly throughout the car.



Scheme No. 3. One of three new experimental railroad coaches

Vacuum Packed Milk

BY passing the top of a full milk bottle through a space filled with live steam and then capping it quickly, milk is now packed in a partial vacuum. The caps used are metal so that when the steam shut up in the small free space in the bottle condenses to leave a vacuum the milk is completely protected. The advantages claimed for the new method of packing are that the milk will remain fresh at room temperature for as long as 48 hours and can be kept in a refrigerator for 6 weeks; the seal cannot be tampered with and is tight enough to prevent any contamination; because the vacuum on the top of the bottle holds the cap tightly in place, there is no leakage either in or out of the bottle. The new method of sealing is carried out on an automatic machine and is completed within 30 seconds.—*D. H. K.*

Million Dollar Track Revives Road Races

A FOUR-MILE, serpentine, dirt track costing a million dollars to build and accommodating more than 50,000 spectators will be ready on the old Roosevelt Field in Long Island, New York City, in October, when about 50 cars will race for prizes totaling about 75,000 dollars. Road racing seemed to be finished in 1917, owing to its dangers, but the new track will bring the sport back with all the thrills but minus many of the hazards. The October event, which will be a 400-mile contest, will be run on a track containing 20 turns—reverse turns, hairpins, double twists, and others—but the track is all on the flat and therefore under engineering control at every turn.

The track carries on the speed tradition of the site on which it is constructed, for it is the field from which transatlantic flights have been started by such ace flyers as Lindbergh, Chamberlin, and Byrd.

George H. Robertson, vice-president and general manager of the Motor Development Corporation of New York, which is building the track and who himself a quarter of a century ago won the Vanderbilt classic, said, in commenting on the plan of the track:

"The track will be protected on each side, the full length of the course, by steel guard rails. Beyond the rails, and between the track and the spectators, there will be a safety zone 30 feet wide. At the edge of this zone there will be a heavy steel wire fence.

"At various points on the course signal lights will be placed, each having a red, a yellow, and a green light. In the event of serious accident, any one of five field judges situated in towers at different points can throw the yellow light to all cars to slow down. The chief judge can throw the red light which will stop all cars if necessary. The green light is the all-clear riding light."

Additional protection is being provided

by concrete walls at the most important turns. Since on the straightaway it is expected that the drivers will be making up to 150 miles an hour, a chute has been provided at the turns so that if the driver overrides the turn he can roll harmlessly down the chute and out of the way of the cars behind him. The track will have a treated dirt surface and the width of the track will vary from 60 feet to 100 feet, while the straightaway will be 80 feet wide except at the pits, where the width is 100 feet. There will be a 150 foot width for the turn at the end of the straightaway—the hardest of all.

Prize Winning Paper on Rocket Design

ANNOUNCEMENT has just been made that the annual prize of 5000 francs awarded in the Rep-Hirsch Astronautical competition in Paris will be divided between the American Rocket Society and Alfred Africano, the author of a paper entitled "Design of a Stratosphere Rocket." We heartily congratulate both the Society and its president, G. E. Pendray, whose patient efforts we have described, and the author, who is following up this triumph by a trip to Europe to survey the latest foreign developments in rocket design.

Mr. Africano has given us permission to abstract his valuable work, and we are all the more happy to do so because it constitutes not only a record of skilled experimentation but a thoroughly sound introduction to this new and difficult art.

First of all there is given a description—for the first time in truly technical form—of how rocket motor experiments may be carried out. While infinite patience and some courage are required for such investigations, the expenditures are relatively small. Other groups besides the American Rocket Society are sure to make similar attempts in various parts of the country.

The arrangement of the proving ground on the estate of Mr. Pendray, the instrument

Rocket proving ground

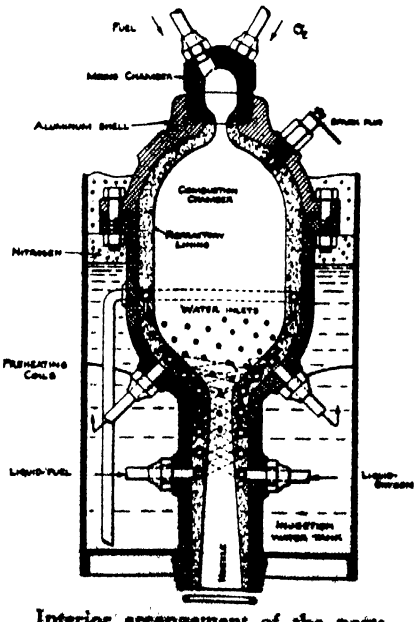
board, and the barricade which protects the experimenters are shown. In another illustration there is a close-up of a typical rocket motor in position for a test.

The main elements of the rocket motor may be listed as follows: a. The nozzle from which the jet issues; b. The aluminum combustion chamber; c. Fuel and oxygen inlet; d. Quick-opening valves; e. Safety valve; f. Hydraulic piston (for test purposes only); g. Copper liquid-oxygen tank; h. Copper liquid-fuel tank; i. Angle-iron

Test set-up for rocket motor

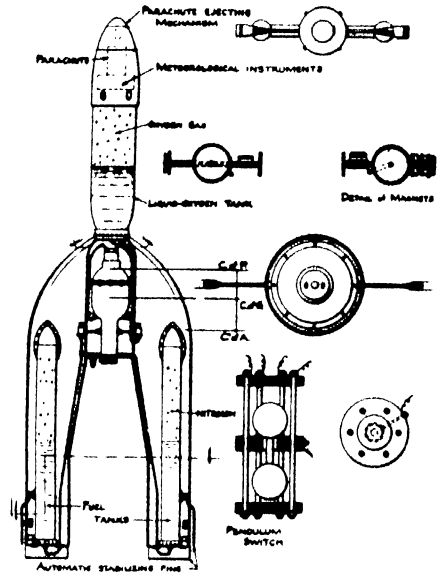
frame of proving stand; j. Pipe connection to chamber pressure gage.

The nozzles used at first were of cast aluminum, which burned out after each run. Later, the nozzles were machined from nichrome steel rod, threaded at the lower end so that they could be screwed into the exhaust end of the combustion chamber. The combustion chamber itself was made of aluminum for all but one of the rockets. It consisted of two cylindrical end parts, shaped inside as hemispheres of one-inch radius. In between the hemispheres cylinders of varying lengths could be inserted and bolted rigidly in place. Thus the effect of varying length/diameter ratios could be determined. The fuel (generally gasoline) and the liquid inlet orifices were drilled in a nichrome plug, screwed into the lower or feed end of the combustion chamber. Both the fuel tank and the liquid oxygen tank were made of copper, three inches in outside diameter and 21½ inches long. The liquid oxygen was poured into the tank by rather primitive methods. As the liquid oxygen (intensely cold to begin with) absorbed heat from the air, it built up pressure in the free space at the top of the oxygen tank. The building up of the pressure was rather slow, about 125 pounds per square inch in a minute's time. Nitrogen gas under a pressure of 450 pounds was forced into the top of the fuel tank. This slow building up of the pressure was a blessing to the investigators since they had plenty of time to run behind the barricade. When a pressure of 450 pounds per square inch in the oxygen tank was also reached, a switch was closed, firing a gunpowder fuse securely fastened to the mouth of the nozzle. The moment this fuse was seen to be burning vigorously, two quick-release valves were opened simultaneously by a tug on a cord.



Interior arrangement of the parts of a rocket motor using liquid fuel

If the method of ignition succeeded—as it generally did—a jet of brilliant white



A contemplated stratosphere rocket and details of some of the important features. A parachute is provided to carry instruments to earth

flame shot up instantly three or four feet from the nozzle and the typical powerful roar of the rocket motor was heard, making the surrounding ground vibrate from the intensity of the sound and forces being released. Reports were that the roar of the jet was heard three miles away, and this will be readily believed by anyone who witnessed the tests.

There was plenty of excitement for the courageous men who practiced this fascinating hobby. But they did not seek amusement alone. On the contrary, little by little they developed a real technique of experimentation.

Since the jet reaction was downward, its thrust was made to force down a piston in a cylinder filled with water. The increased water pressure registered on a gage, and gave a continuous indication of the amount of thrust obtained during a run. A second gage was connected to the fuel tank measuring the pressure of the nitrogen gas as it forced the fuel into the combustion chamber. A third gage measured the pressure built up above the liquid oxygen. A fourth recorded pressures in the combustion chamber. The fifth dial showed the time of combustion in seconds.

By photographing these dials simultaneously with a motion picture camera, the exact relationships of these five quantities at all times during combustion was permanently recorded. In addition, detailed records were kept during each run of the kind and amount of fuel and liquid

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oxygen used, the rocket motor dimensions, and all observed phenomena. Something like a pint of gasoline was used on the average run, and about a quart of liquid oxygen.

With the chamber of dimensions previously given, and with a nozzle throat of about ½ inch diameter, jet reactions of between 57 and 128 pounds were secured. The duration of the reaction was about eight seconds. The velocity of the exit jet was estimated to be about 4000 feet per second. The thermal efficiency was somewhere in the neighborhood of 6 to 8 percent, which is low.

A great number of things were learned from these tests. Alcohol proved a more efficient fuel than gasoline. Nichrome nozzles stood up remarkably well under the terrific temperatures of 3000 degrees, Fahrenheit (so estimated from the white color of the jet flame), much better than the cast aluminum nozzles which were first thought to be adequate. A carbon chamber and nozzle proved unsatisfactory. The alcohol burned more smoothly than the gasoline because of its chemical homogeneity. Contrary to a general belief, the liquid fuels proved to be infinitely superior to gunpowder. Gunpowder is violent, dangerous, acts much more quickly than the liquid fuels but develops a smaller value of jet reaction multiplied by time. If these experiments had done nothing more than dispel the notion that gunpowder can be used for rockets, they would have thoroughly justified themselves.

We cannot, unfortunately, go into all the mathematical treatment which Mr. Africano has given this subject. His paper will be a classic from which references will be drawn for many years to come. In particular, he has gone carefully into the actual design of a rocket for high altitude flight. While the present thermal efficiency and the propulsive efficiency of the rocket motor are low, Mr. Africano has made out an excellent theoretical case for a high speed high altitude rocket, with serious possibilities for meteorological and cosmic ray research, and with possibilities also as an offensive weapon. It is a strange thing that every advance in applied science seems to lead to a new method of destruction.

Without going into the actual calculations, we shall refer briefly to two sketch designs which the author has supplied.

A careful reader, by following these diagrams, will see readily how the experience gathered at the test stand has led to an entirely logical conception of a rocket motor with combustion chamber, water cooling, refractory linings, ignition, nitrogen control of the fuel, and so on. One of the diagrams shows a stratosphere rocket equipped with a parachute-ejecting mechanism to carry the meteorological instruments down safely. A magnetic control is also provided for the parachute ejection.—*A. K.*

A Hardship to Private Fliers

AN elaborate system of traffic control has been developed by the Department of Commerce. Flights on a heading from zero to 179 degrees—that is, east, generally speaking—must be at odd thousand feet, that is 1000, 3000, 5000 feet, and so on. Flights on a heading from 180 to 359—that is, West—are at even thousand feet, 2000, 4000, and so on. Crossings are at 500, 1500, 2500 feet, and so on.

Air transport planes fly according to this formula and are in contact with the airport by two-way radio so that overtaking at the same level, or collisions are guarded against. Pilots leaving airports receive careful instructions.

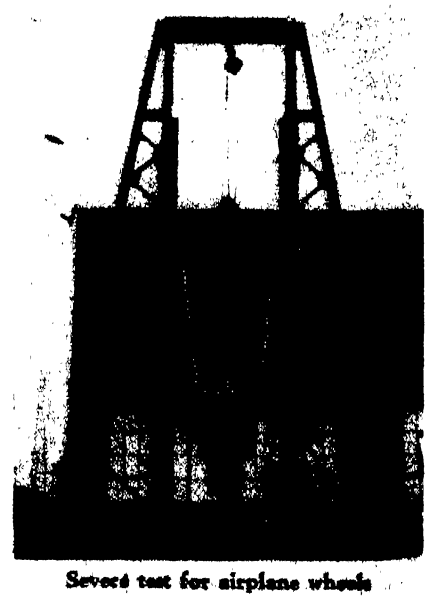
But private planes are not as a rule equipped with two-way radio telephone, because of the expense involved. In conditions of low visibility they do not receive permission to use airways. That is a serious hardship for private owners who wish to use the airway aids to navigation in cross-country work. Yet how can the rule be changed? The answer is that the rules cannot be changed, but that manufacturers must find a way of building inexpensive sets, and they are already working on these lines. Moreover, if a ship has been bonded with copper strips connecting all metal parts, a radio telephone set can be rented and quickly installed for a special flight.—*A. K.*

Largest Drop Test Jig

ELABORATE methods of calculating the strength of the airplane have been developed, and structural failures in flying are rare indeed. Nevertheless, engineers sometimes prefer to test various parts of the aircraft to destruction instead of relying solely on calculation. One of our photographs shows the method employed by the Boeing Aircraft Company in testing the main landing gear assembly of one of its giant four-engined bombers. This "drop-test jig" is the largest in the world.

Thirty feet in height, the jig is constructed of structural steel on a concrete foundation. Loads are placed on a moving carriage which is guided by large ball bearings fitted around a track running the entire vertical length of the jig.

To simulate the shocks likely to meet the bomber in a rough landing, a load of 16,000 pounds of lead was placed on the carriage of the jig and dropped 24 inches to produce the tremendous impact load of approximately 40 tons. As the entire gross weight of the bomber is only 16 tons, and as this weight is distributed between the two wheels, this means that the landing gear



Severe test for airplane wheels

and shock-absorbing struts were able to absorb more than five times the weight of the airplane—which is considered ample strength by the best authorities.—*A. K.*

Should Airplane Fares Be Reduced?

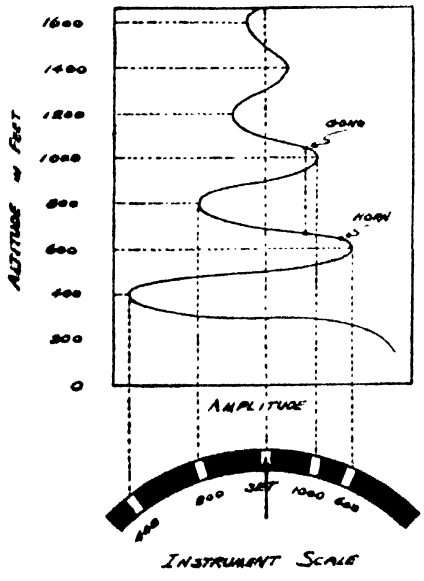
AIRLINE passenger fares average six cents per mile. Until June 1, 1936, this compared favorably with rail plus Pullman fares. After that date the cost of rail plus Pullman was reduced about 20 percent.

But last year there were 746,969 paid fares on the domestic airlines, yet only 200,000 individuals traveled by air. This indicates that people who use the air do so frequently and they can reduce the cost of air travel by buying scrip tickets (500 dollars worth of air transportation for only 425 dollars). Also, obsolescence in air transport is rapid, equipment is expensive, and the higher cost of tickets is more than balanced by the time saved, the reduced expense for meals while traveling, and so on.

Hence the opinion of a well informed group of aviation men, chatting peacefully after lunch, was that air travel is worth some differential and that the operators who are just coming out of the red should keep to the present scale of prices for some little time.—*A. K.*

A Radio Echo Altimeter

SOME eight years ago Dr. E. F. W. Alexanderson of the General Electric Company developed and tested a radio echo altimeter of considerable promise. No detailed description was ever released, and the instrument did not pass into commercial use. Now that fog and blind flying are more

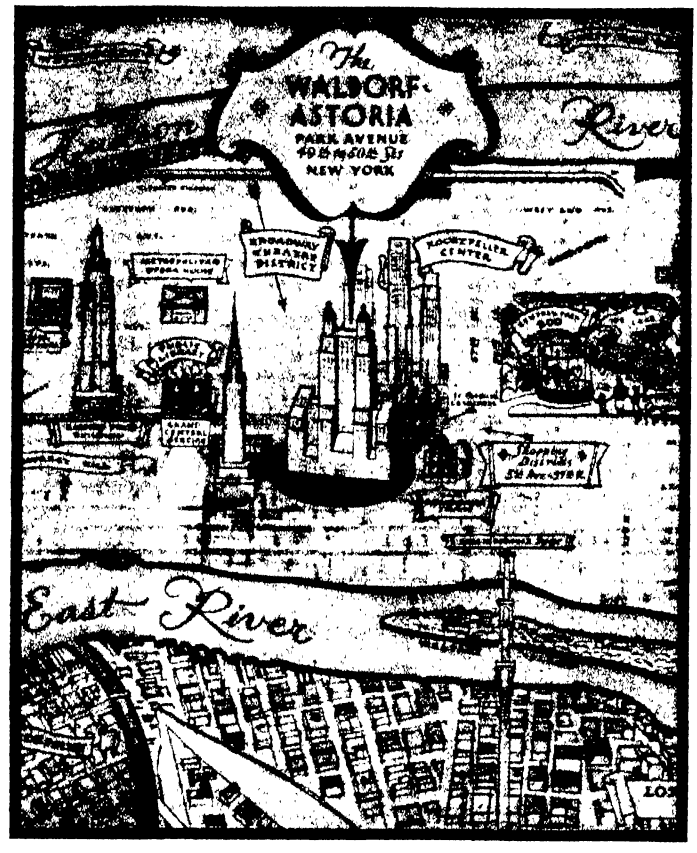


Indications on the radio altimeter

commonly practiced, interest in the radio echo altimeter is reviving, and we were glad to read even a rudimentary description of the device in the *Journal of the Aeronautical Sciences.*

The radio echo altimeter consists of a single-tube radio receiver, operated with a single wire antenna trailing behind the plane. The receiver is so designed and adjusted that it radiates a wave towards the ground and almost simultaneously receives the echo reflection of this wave returning from the ground.

The radiated and reflected wave combine



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The Technic of Sleeping

Do you count sheep, review the activities of the day, or outline your course for the morrow, to induce sleep? Going to sleep promptly is, to a large extent, a matter of educating your body and mind to complete relaxation. This article may be the key that will unlock the door to a happier, more healthful 24-hour day, both while you are awake and asleep.

15 to 85 Per Cent Harbor Pneumonia Germs

Reports from group examinations reveal these startling figures. Consequently many healthy individuals can, under certain conditions, become seriously ill with the disease without the slightest expectation or warning. What you as a layman should know about pneumonia and its control is clearly explained by Dr. Herschensohn in "The Pneumococcus".

Will Neglect Ever Place You in the Hospital?

Let us take a brief visit to a hospital. Here we will see club-footed Jimmie, age 7, in agony because correction was not started when 10 days old; Betty, four years old, dying from diphtheria—no toxin—antitoxin or toxoid was given at 6 months; an infant with congenital syphilis whose mother considered it a nuisance to take weekly treatments; a young man who took castor oil to relieve a severe abdominal pain; and many, many similar cases, each a pitiful and all too common sacrifice on the altar of neglect. Will you be guilty? Read "IT NEVER SHOULD HAVE HAPPENED".

Keeping Your Mental Poise

Are you a calm and collected individual every minute of the day? Do you believe that you are immune to hysteria? What is hysteria, what causes it, how does it make a person act under extreme conditions and what should be done about it? For the answers to these and a multitude of other questions about the human mind, be sure to read "THE HIDDEN MONSTER".

The "Lonely Child" Problem

Both rich and poor may be guilty of heaping coals instead of sympathy and understanding upon the head of the lonesome child. A large majority of cases could be avoided—if parents would only give a little consideration to the cause and take definite steps to have it removed. This article will help you to recognize what the causes are and tell you how to go about eliminating them

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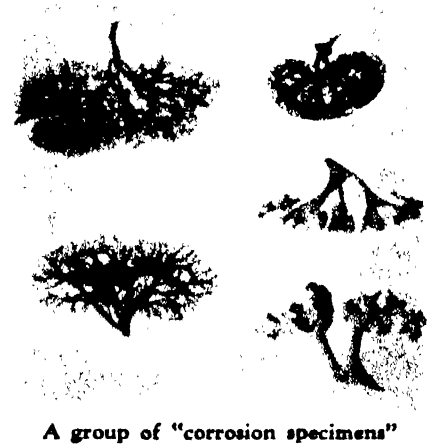
into the characteristic patterns of a "standing" wave with well defined maxima and minima which are directly indicated on an instrument dial. The appended diagram illustrates the working of the instrument. At some predetermined height—say 1500 feet or more—the pointer is at "set." If the height above the ground drops to a little over 1000 feet a gong rings. At 650 feet, a horn sounds. Below this the needle swings with more and more amplitude. Thus, warning to the pilot flying over hilly country is complete. Flight tests proved satisfactory under conditions simulating what is likely to occur in actual cross country work. The whole instrument weighed only six and one half pounds.—*A. K.*

OCEAN TREASURE

ONE square mile of the Atlantic Ocean 76 feet deep carried a treasure of 73,094,600 dollars as it was pumped through the bromine plant near Wilmington, North Carolina, during the past 12 months. That plant was interested, however, only in the ethylene dibromide.

"CORROSION SPECIMENS"

PHYSICIANS are interested in the blood vessels which supply each organ of the human body or any animal organism with blood. They are constantly studying the arteries which carry blood from the heart to the organs, as well as the veins which carry blood away from the various organs to the heart. In order to make these vessels visible in organs removed from the body,



A group of "corrosion specimens"

a new method has been developed by Dr. Joseph K. Narat at the University of Illinois, College of Medicine.

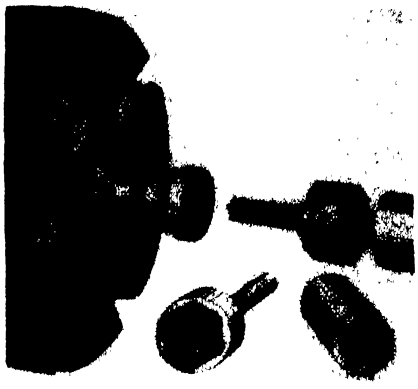
The organ is freed from blood by flushing the blood vessels with water and an air stream. After that the resin Vinylite is injected into the blood vessels. A manometer gages the necessary pressure. The solution of resin injected into the arteries is stained red, and that injected into the veins is stained blue. After the injections, the blood vessels leading to the organ are tied with a string to prevent leakage. The organ is then immersed in water for 24 hours; the resin solution precipitates and solidifies.

The next step is to transfer the organ to a concentrated solution of hydrochloric acid, in which it remains for three or four days. The acid gradually digests all the

tissues except the injected blood vessels. After the organ has been removed from the acid and washed with water, a specimen is obtained which reproduces the blood vessels, the distribution and shape of which can now be studied.

Rotating Drills—Square Holes

THE old conception of utter impossibility expressed in the traditional "square peg-round hole" idea must be revised. The rotating drill which, as everyone knows, has always been used to drill round holes, has



The drill rotates, but produces holes with square or other angles

now been so modified that it will produce not only square holes but triangles, hexagons, and pentagons. Watts Brothers Tool Works are producing angular drilling tools which do this job so successfully that large numbers of nationally known companies are now using this equipment. The angular drills look more like heavily fluted reamers and are used in connection with full floating chucks.

To cut a square hole with the speed of an ordinary drilling operation, a Watts drill of three lips is used. The heel of each "land" rocks the drill into turning a corner as its lip finishes a side cut. The full floating motion of the chuck allows the drill to move off the center in a series of minute, alternate cycloid curves the cords of which are parallel to the sides of the hole being drilled. The eccentric shape of the drill heel, under this motion, forces the lips to parallel these cords. The completed hole is perfectly matched so that no additional hand tooling is necessary.

Many uses have been found for this equipment, for the drills cut high carbon steels, iron, cast iron, brass, aluminum, micarta, Bakelite, and so on.

Makers of socket wrenches have found that wrenches drilled in this manner are stronger and cheaper. Automobile manufacturers and machinery makers are counterboring round holes to take square or hexagonal bolt heads with Watts drills.

Psychoanalysis for $5,000

YOU need to have money, maturity, and intelligence before you put yourself into the hands of a psychoanalyst. So states Dr. Harold Thomas Hyman, New York City physician, who for 15 years has been collecting experiences in this method of treating human ills.

Dr. Hyman who, needless to say, is not a psychoanalyst, reports on 43 cases treated by psychoanalysis in the *Journal of the*

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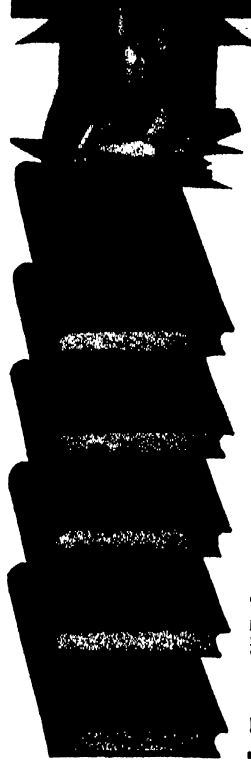

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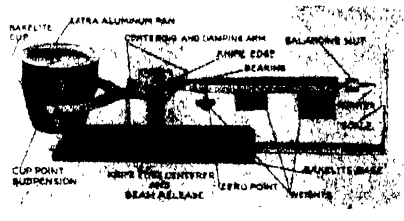

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American Medical Association. From Dr. Hyman we learn that the total fee for psychoanalysis averages between 5000 and 6000 dollars a case. The average visit costs the patient something less than 10 dollars, and there are likely to be from 250 to 270 sessions a year. It takes from 18 months to two years to terminate an analysis.

Although those who practice the Freudian method claim that age is not a factor in treatment, Dr. Hyman holds that before the middle twenties only the unusual person can obtain any insight into the procedure. Beyond the age of 40 or 45 there seems little possibility of altering individuals, he declares.

The successful patient must have a plastic and trained intelligence. As a rule such patients are recruited from the professions and the arts. The average man or woman is wholly unable to grasp or to utilize this form of therapy, in his opinion. Those with profound psychiatric disorders have neither the receptive attitude nor the moral fiber to profit from the information that is disclosed.

Among the 43 cases Dr. Hyman discusses, 15 suffered from profound psychiatric disease. The treatment of 12 of these by psychoanalysis resulted in "dismal failures." In two patients the results are still questionable, and one—a homosexual—made a brilliant recovery.

Twenty-eight patients suffered from less serious disorders hysteria, anxiety states, obsessions, and the like. Seventeen of these were distinctly benefited, and 11 experienced no significant aid, according to this critic.—*Science Service.*

WHALE-OIL VARNISHES

BY suitable treatment whale-oil varnishes are made in Germany which dry quickly to yield an excellent film comparable with that of linseed-oil varnishes. Other treatments of whale oil produce a thick product which can be used as a plasticizer or softener for nitrocellulose lacquers, and which functions well in the four-hour varnishes now made with tung oil.—*D. H. K.*

WIDE WIND PITS FOLLOW OVERGRAZING

HUGE pits covering as much as six acres and reaching a depth of 15 feet in some places, supply vivid evidence of the disastrous effects of wind erosion on grazing lands of the west. In one demonstration area of the Soil Conservation Service, in north central Utah, the wind has dug several of these yawning land eaters.

Before the demonstration was started, none of the land in the Utah project area had been fenced or plowed and there had been little or no control over grazing. As a result, overgrazing practically killed out the native grasses and browse plants which formerly grew in this section and held the soil in place.

Wind erosion may occur any place where overgrazing, overcutting of timber, or some other form of land abuse has left the soil unprotected from the ripping action of the wind. Already dust "blizzards" have done great damage in the southwest and in the Dakotas.

In combating wind erosion in the Utah demonstration area, in Salt Lake and Tooele Counties, grazing has been restricted and a good start has been made toward

starting new plant growth on the land. The Soil Conservation Service is introducing several varieties of grass, including crested wheat grass, in an attempt to keep the soil out of the air and make the country suitable once again for grazing and agriculture.

The Abbot Sun-Power Boiler

SUN power will be translated into steam engine power in the near future at the Smithsonian Institution at Washington, D. C. Dr. Charles G. Abbot, the Institution's secretary, is now engaged in putting the finishing touches on an apparatus in which 36 square feet of aluminum mirror surface will capture enough of the poured-out energy of the world's central heating plant to run a one-half horsepower engine, *Science Service* reports.

Dr. Abbot's new apparatus represents an improved evolution from earlier experimental models. Every part has been carefully planned to achieve a higher thermal efficiency than has ever been attained with solar boilers and other types of sun-heating apparatus.

Dr. Abbot states that the efficiency of his "sun-fired" boiler will be about 15 percent, which compares favorably with the efficiency of a coal- or oil-fired boiler—with the advantage that its fuel cost is zero.

Vitamin D Skin Cream

BASED on the latest researches in vitamins, cosmetic preparations are now being marketed which give milady vitamin D, the sunshine vitamin, in a form readily assimilable through the skin. In other words, it is possible by the use of cosmetic creams to give a person the effect of a sun bath in the dark. Several manufacturers have applied research findings on the absorption of vitamin D from fats containing it through the skin to improve their products in this respect. Careful tests, according to R. Schuler writing in *Drug & Cosmetic Industry*, have shown that rickets in rats can be cured by the administration of vitamin D dissolved in fats to the skin of the animal. Despite the advantage to persons of creams of this kind, it is hardly likely that they will make it unnecessary to include this vitamin in the diet since the curative dose as applied through the skin is about ten times greater than that required in food.—*D. H. K.*

Break Your Matches in the Woods

"THE careless smoker is a forest enemy. The careful smoker is a forest friend," says the United States Forest Service. Careless smokers—who neglect a few simple precautions—caused 47,845 fires last year, or 23 percent of all forest fires.

Careless smokers started more fires than were started by railroads, logging, and debris burning; more than three times the number caused by carelessly left campfires; and more than three times the number set by lightning.

A real woodsman always breaks his matches in two before casting them aside—a little habit which makes sure that every match is "out," says the Forest Service. He also crushes out the fire in pipe ashes and

(*Please turn to page* 237)

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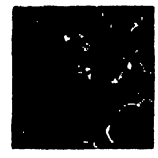

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THE AMATEUR TELESCOPE MAKER

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NOW and then someone makes a reflector of the Gregorian type, and one such telescope (Figure 1) was made by Paul A. Chamberlain, 8054 Honore St., Chicago, Ill., who writes:

"The mirror is a disk of No. 5 Carpenter stainless steel, forged to 8¼" x 1", machined to 8" x ⅞", ground, polished and figured. It weighs 16 pounds. The secondary is of No. 3 Carpenter stainless steel similarly handled. Both are chrome plated. The focus of the primary is 34", radius of curvature of secondary is 10¼". *P* measures 5.75" and P' 47.25", *e.f.l.* being *f*/32.

"The tube is made of six duralumin tees. The fork, polar axis housing, cell, short tube around cell, and support for secondary are all aluminum castings. The polar axis has

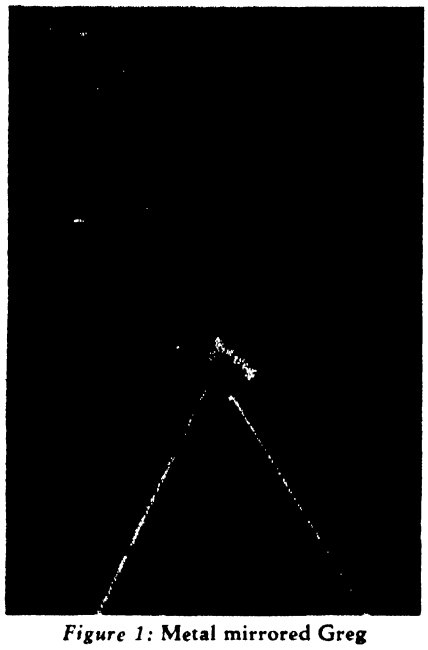

Figure 1: **Metal mirrored Greg**

roller bearings. The declination axis is 1".

"The tripod is made of three 1½" O.D. duralumin tubes. The eyepiece holder is fastened to a tube which swings around the optical axis. Having used some telescopes which require the observer to be a contortionist, I determined to arrange my instrument so that after using it some time I could look the neighbors straight in the face. The observer can be seated while at work. The total cost was $59." [The details of grinding and figuring this metal mirror will not be presented here, having been included in a chapter on that subject in Vol. II, "A.T.M." This is now at the printer's and will be announced when really—considerably later in the autumn.—*Ed.*]

HEAVY oak tripod legs instead of the spidery legs sometimes seen on tripods characterize the 6" telescope in Figure 2, made by Newman E. Brown, 414 Connecticut Drive, Erie, Pa. He says: "The tube consists of a sheet of rawhide fiber, .060" thick, rolled up on a mandrel to three thicknesses. I cemented each layer as I went around, and riveted the final edge. This makes a tube of

Figure 2: **Rawhide tube, good legs**

remarkable rigidity, and exclusive of optical parts, weighs only 9½ pounds.

"The mounting consists of a worm gear steering unit from an old automobile. The gear shaft serves as my polar axis.

"All material, except optical parts, I obtained from scrap of a large industrial plant at a total cost of about three dollars."

"WHAT interests me is the new found use for another flivver part—the rear axle housing, as a pedestal," Russell W. Porter commented when shown the photograph in Figure 3. Welby Powell, R.F.D. 1, Clarksville, Tenn., is the maker. His letter:

"I have completed my first telescope, which has an 8" mirror of Pyrex. I used your book, 'Amateur Telescope Making,' as a

Figure 3: **Note altitude screw**

guide and picked up some 'Don'ts' of my own.

"My mounting is a portable type which I built from discarded machine parts, excepting the tube which I rolled from 20-gage iron. I wanted to get away from the necessity of following the eyepiece into so many inconvenient and almost impossible positions, so I fitted it into the journal of the declination axis. You might call it a portable mounting with a fixed eyepiece." [Note that all of the telescopes in Figures 1 to 6 are portable.—*Ed.*]

MOUNTING a 12" telescope semi-portably is no problem if you don't have to trundle it far. Figure 4 shows such a one, made by Edward J. Hejna, 3358 Jasper St., Philadelphia, Pa. It is a "Wheelemout" Type.

"I read about the 'Twelve Inch Club' in the June number," he writes, "and am send-

Figure 4: **New member of 12" Club**

ing a photograph of my telescope, which has a 12 7/16" mirror of *f*/8 ratio. The polar axis shaft is 1 3/16" in diameter, solid, and runs on ball bearings. The base is on ball bearing casters and the total weight of 550 pounds may be raised on three screws, making the telescope very steady." Mr. Hejna wishes to exchange photographs of telescopes with other amateurs.

A VERY portable portable is shown in Figures 5 and 6, and was made by Merle Foster, 677 32nd St., Oakland, Calif. "While it is portable," he says, "it can also be readily attached to a stationary mounting. But when the atmosphere does not permit clear observation it can be placed in a

Figure 5: "Slip-stick folder-up"

car and easily taken to a better locality.

"The backbone has a focusing and folding mechanism, like a slide rule, and this also permits focusing on relatively close terrestrial objects, as well as compact folding. It has a rack and gear."

ONE telescope which is *not* portable—it weighs 1000 pounds—is shown in Figure 7. Joseph E. Boehm, 3511 N. Seminary Ave., Chicago, Ill., is the maker and he says he has been plugging at the job, which is an unusual one, for the past five years. It is a 14" and, in its observatory (Figure 8), is situated at Lake Geneva, Wisconsin. But let us have the description from the tenacious maker. A man who will stick to a job five years must have determination.

"The telescope is a Cass-Newt combination. The f/5 primary mirror is used with a 4½" x 6½" Newt diagonal to cover a wide field for photography.

"Tube assembly is of all-aluminum construction and consists of a tube, internally reinforced, having a cast ring at its lower end which supports the threaded, removable mirror cell. Duplicate threaded tube outlets permit accessories to be interchangeable for either Cass or Newt observing position. A declination setting circle and 4000-to-1 slow motion are provided. Declination bearings are bronze.

"The hollow cast aluminum fork was bored out undersize and hydraulically pressed on the 3¼" steel polar axis shaft. Upper

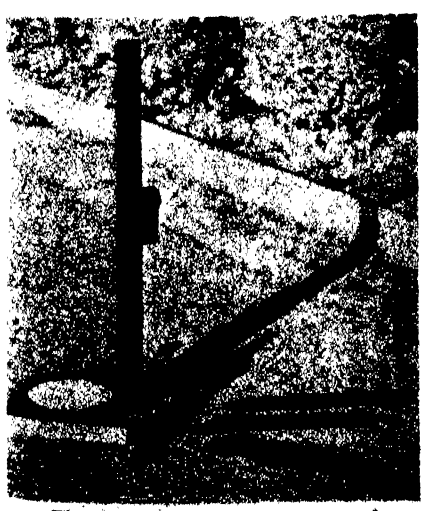

Figure 6: Dissected—compacted

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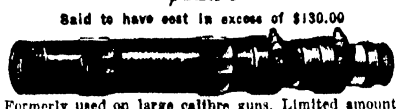

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Figure 7: **Five years at hard labor**

polar axis bearing is bronze, while the lower bearing is a 6" annular ball bearing. The R.A. setting circle is electrically driven to eliminate setting calculations.

"The cast-iron base weighs 600 lbs. and is mounted on a concrete pier extending 12' below ground level.

"Weight of the entire telescope is around 1000 lbs.; the tube assembly alone weighs about 150 lbs. Contained in the instrument are 32 castings, for which 19 patterns were made by myself."

Mr. Boehm's description of the electric drive of this big telescope, with its design, has been included in "A.T.M.," Vol. II, as an example of a drive for a telescope of larger size, such as more and more amateurs now aspire to make. He continues, with regard to his observatory building (Figure 8):

"The 12' x 12' building is mounted on six concrete posts, 10' deep, due to the unsteady ground conditions. The sliding roof is split at the ridge, each half being counterweighted and sliding independently on rubber rollers. Only about half of the total roof area is movable. The roof 'overhangs,' as well as the lower one third of the roof, are stationary, the latter being depressed to allow the sliding portion to pass over it. This depressed portion also supports the sliding roof when in open position. This construction greatly reduces the weight of the sliding roof, requires no external roof supports, and helps to preserve the trim lines of the observatory building when the roof is open.

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PITCH testers again. F. C. Woods, 108 North Cherry St., Galesburg, Ill., has made two, and writes:

"Here is a picture of a pitch tester which I believe overcomes some of the difficulties which I encountered in using one I built after the illustration in the October, 1935, Scientific American. Of this type I built a rather elaborate one (Figure 9), only to discover that the pivots had to be quite tight to take care of the upward thrust given by the point as it enters the pitch. In the one I have devised (Figure 10) the only moving part is the central rod which carries the needle point (.0395" diameter).

"The degree indicator can be quickly removed and the micrometer head put in its place, thereby enabling the hardness of the pitch to be measured in 1/1000". Neither the degree indicator nor the micrometer head is necessary, as divisions could be made directly on the shaft and read from a pointer attached to the standard. The rulings should probably be in thousandths of an inch and read with a magnifying glass.

"In the operation of the machine the shaft is set so that the pointer is at zero, and the shaft is held stationary by the thumbscrew at the upper cross bar. The pitch is then brought firmly to the point and locked in position; then, with watch ready, the thumbscrew is loosened for the predetermined period and again the thumb nut is tightened, locking the shaft.

"If anyone should build a pitch tester after this design, it would be best to make the shaft that holds the point and weights ½" in diameter if a micrometer is used. I have already redesigned it to prevent flexing of any part of it."

JUST as these pages are put together this scribe is down from Vermont, after the eleventh annual convention, get-together or powwow of amateur telescope enthusiasts held at *Stellafane*. This year the attendance was 248, considerably larger than ever before. The amateur astronomical and telescope making movement "marches on," and one wonders what and where it will be in another decade.

Persons who are in a good position to watch statistics note that there never has been a retreat since the movement began. Instead, there has been a steady growth all along: "one man tells another." It looks as if everybody and even his wife would ultimately be pushing glass.

No ballyhoo methods—none of the artificial inflation methods so dear to some public relations counsels and "builder-up men"—have ever been used. It was thought better from the first to give the hobby its head and let it develop naturally, going wherever it wished.

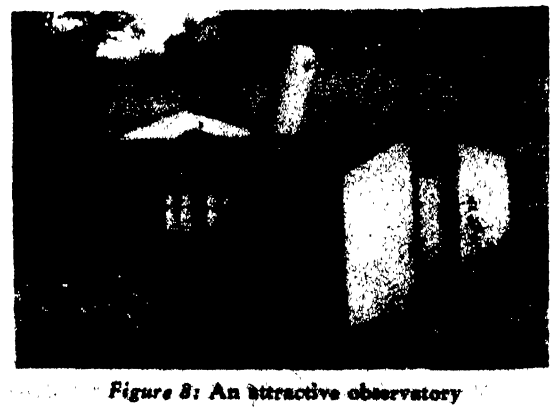

Figure 8: **An attractive observatory**

Figure 9: **McCarrol type tester**

We have even been reproached, in a few instances, for not "developing" it by various available high-pressure means. A really "live" organizer, we were told, would have blown the hobby up to much greater proportions in many fewer years. This is true—it could have been done. But then the bubble would have burst the sooner, leaving only that "morning after the night before" feeling. What such a thing really would have done is simply to inflate the hobby with a lot of people who lack sufficient carry-through to stick to telescope making more than three months or so. On the other hand, the hobby is its own quiet salesman to the right kind of folks—meaning by this, the kind of fellows who can handle the work and like it, and who don't peter out.

The *Stellafane* powwows are a lot of fun, chiefly, some think, for a reason which is of a piece with something mentioned above—folks come and are pretty generally left alone to do what they please. They add themselves to the crowd and begin chinning with the first telescope nut they see; and so it goes, all the (Saturday) afternoon and evening—all night for the owl fraction—and part of the next day, when the hold-overs drift away. The only semblance of a "session" is a group of informal "speeches" at dusk, mostly made in shirt sleeves.

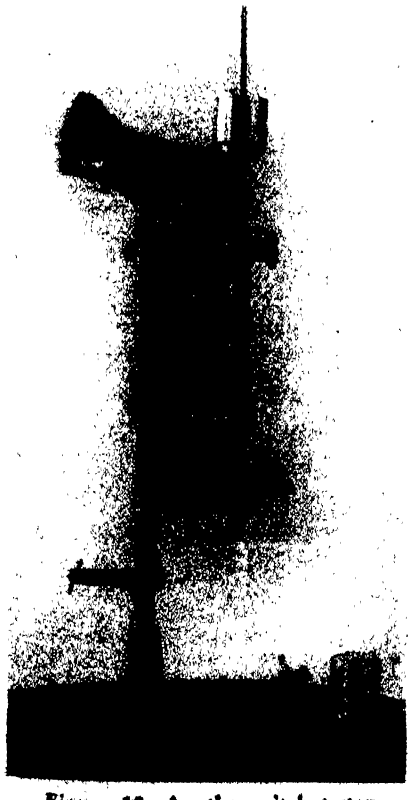

Figure 10: **Another pitch tester**

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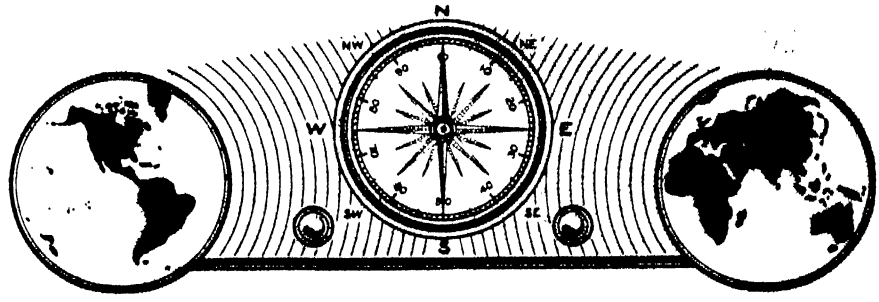


WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN
Editor, *All-Wave Radio*

Amateur Phone Stations

MANY DX stations can be picked up in the amateur bands this time of year. There are two stations operating in Georgetown, British Guinea. They are VP3BG and VP3MR and operate on frequencies of 7.22 and 7.08 megacycles, respectively.

Captain Bob Bartlett's Schooner *Morrissey* is on another trip to Greenland. The phone transmitter is being operated by an amateur and has been heard on a frequency of 14.25 megacycles. The call is W10XDA.

A few of the other amateurs operating phone transmitters in the 20-meter or 14-megacycle band who may be heard almost nightly are: G5NI, England; LU8AB, Argentina; EA8AL, Canary Islands; SU8MA, Egypt; NY2AE, Panama Canal; PY2ET, Brazil; YV4AC, Venezuela; EI2J, Ireland; CO6OM, Cuba; HI5X, Dominica, etc. If the band remains open after midnight, there is a good opportunity of picking up some Australian amateurs.

New Custom Receiver

THE 1937 model Masterpiece Receiver, introduced by the McMurdo Silver Corporation, is a good example of the type of custom-built set produced these days for the discriminating all-wave listener. It also serves as an example of modern mechanical and electrical design trends in the radio field.

The receiver and its power supply-power amplifier unit use 20 tubes. The cone of the loudspeaker is 18 inches in diameter. The dial scale on the front panel of the receiver is nine inches in diameter. The pointer that traverses the scale has a knife edge that eliminates the parallax reading error often encountered.

The receiver has five tuning ranges, covering wavelengths from 2140 to 700 meters and 560 to 4 meters. A volume expander is used in conjunction with the audio amplifier for the purpose of increasing the dynamic range of orchestral music. Two of the new 6L6 beam-power tubes are used in the amplifier and these provide an audio output in the vicinity of 32 watts on volume peaks.

The audio-frequency range of the receiver is said to be from 20 to 9000 cycles, with facilities to cut down to 6000 cycles for reception from stations that do not cover such a wide tone range.

Chinese Station

WEST Coast listeners report hearing Chinese street songs over XGW, Shanghai, on 10.42 megacycles, between 4 A.M. and 1 P.M. Eastern Standard Time.

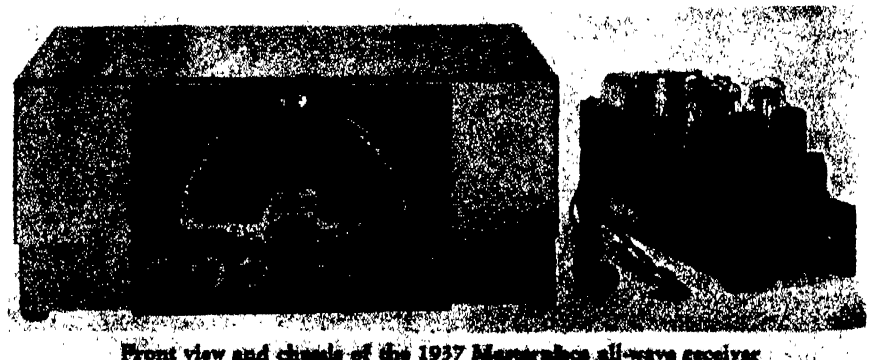
It should be possible to receive this station on the East Coast as well. The Japanese stations come through regularly and with good signal strength.

Foreign Broadcast Band

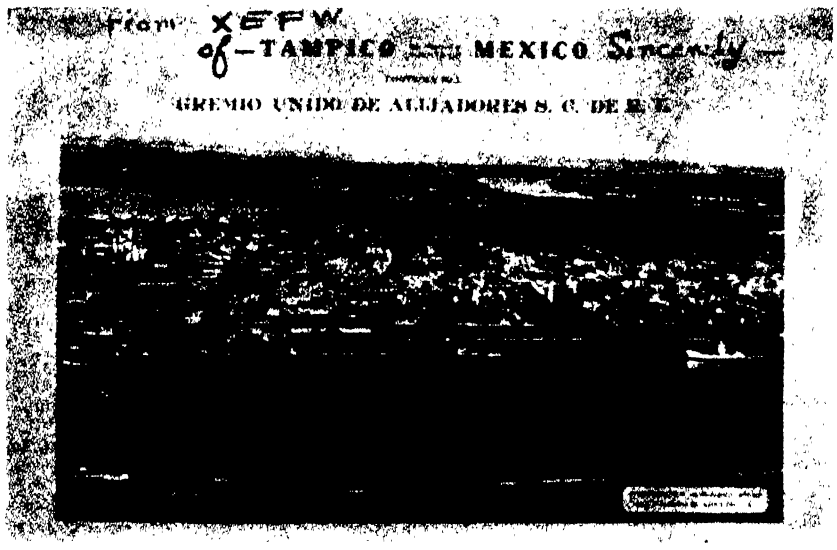
THE reception of distant stations is by no means confined to the short-wave bands. The standard broadcast band holds its share of foreign stations that may be heard in this country with good volume after the more powerful domestic stations shut down for the night.

There are, as a matter of fact, about as many foreign stations operating in the band of frequencies from approximately 550 to 1500 kilocycles, as there are operating in the numerous short-wave broadcasting channels. As a rule, however, it is not possible to intercept these stations until well after midnight due to the interference set up by the stations in the United States utilizing the same wave bands. Moreover, these foreign stations are difficult to pick up in the U. S. during the torrid months.

But, beginning about October 1, many of



Front view and chassis of the 1937 Masterpiece all-wave receiver



A verification card from a Mexican broadcaster

the foreign broadcasters will be laying down good signals over here, and such listeners who enjoy an occasional watch into the early hours of the morning are assured of at least a few good foreign catches.

Many foreign broadcasters have jacked up their transmitting power. England, Germany, and France, in particular, have had super-power stations under construction, and these transmitters will no doubt be placed into service in the very near future, if they are not already on the air.

Transmissions from these stations are particularly interesting since they are prepared for home consumption, or for the consumption of the natives of a neighboring country. Seldom are programs prepared with an eye to America, as is often the case with the programs transmitted from foreign short-wave stations.

Most of the foreign broadcast stations operate on even frequencies, with a 10-kilocycle spacing between stations, so that their signals fall in the same spectrum spaces as our own domestic broadcasters. A few of them, however, operate on split frequencies—such as 756 kilocycles—so that the signals appear between the signals of local stations. Therefore, if the receiver dial calibrations are fairly precise, it may be assumed that any signals heard on odd or split frequencies originated in a foreign country.

Signals from these stations reach their peak in midwinter, but now is the time to commence fishing for them.

1937 All-Wave Receivers

NOTABLE improvements have been made in the new crop of all-wave receivers now on the market. Self-seeking circuits are used in many of the 1937 sets, among the makes being Philco, Crosley, and General Electric. By means of this circuit the listener is not called upon to make delicate tuning adjustments; it is only necessary that the receiver be tuned to within five kilocycles of the desired station frequency at which point the self-seeking circuit comes into play and completes the tuning automatically. This scheme does away with the necessity of using a tuning meter or indicator to assure precise tuning.

The self-seeking circuit has made possible the practical application to a radio receiver of various systems of automatic tuning. Grunow is using an arrangement which operates somewhat like the dial on a telephone. Small tabs carrying the call letters of favorite stations are inserted behind a rotable face plate with circular apertures. By inserting a finger in the proper aperture and flipping the plate, the desired station is "dialed in."

Most of the new all-wave receivers have greater band spread, making it easier to tune in stations in the short-wave bands. By means of these band-spread arrangements, stations are well separated on the dial scale from each other. The result is that tuning in the short-wave stations is about as simple as tuning in stations in the standard broadcast band.

There is a distinct trend toward the use of air trimmers and iron-core intermediate-frequency transformers. The air trimmers insure permanent accuracy of circuit adjustment, while the iron-core I-F transformers provide greater sensitivity or gain in the intermediate-frequency stages. In some receivers the iron cores are made adjustable. They are set to resonance at the factory.

Frequency response has been greatly improved, although there is a hesitancy on the part of many manufacturers to carry the response too far into the upper registers where noise and station interference become problems. Nevertheless, the response has been carried far enough into the higher regions to provide quality of tone not approached by most of the earlier receivers. Moreover, the response has been extended into the lower frequency regions and the bass frequencies supported by much greater reserve power.

Time Signals

TIME signals from the United States Naval Observatory in Washington are broadcast daily on short waves through the naval radio station at Arlington, Virginia. The broadcasts occur at 11:58 A.M., E.S.T. and are on frequencies of 8150 kc, 12,225 kc, and 16,300 kc.

The broadcasts commence with a series of one-second signals preliminary to sending the noon signal, which lasts exactly three-tenths of a second, starting at noon sharp after ten seconds of silence.

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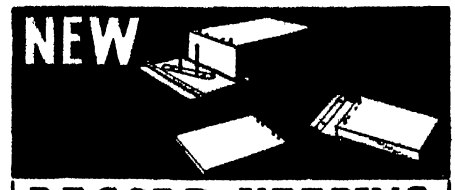

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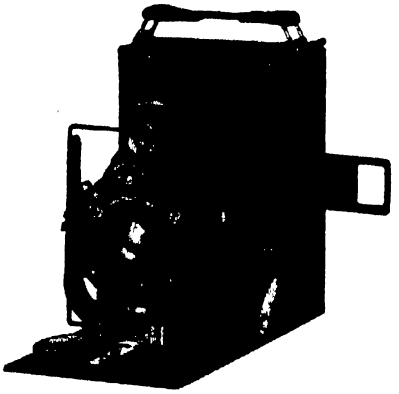

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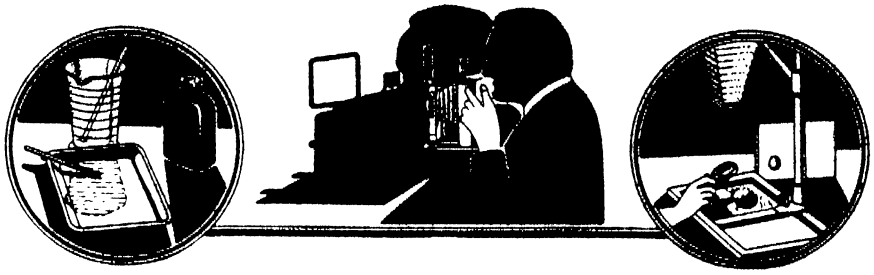


CAMERA ANGLES

Conducted by JACOB DESCHIN

PHOTOMICROGRAPHY

TO the sum of pleasures that fill the leisure hours of the camera-hobbyist, add photomicrography. Its attractions are many-faceted and every camera user can find in it at least one good reason for taking it up as a pastime. Microscopy, the art of viewing microscopic objects enlarged to great proportions, has for a long time been the delight of hobby riders. But since the audience to which the marvels visible through the lens of a given microscope is necessarily limited to one, the camera-hobbyist finds in this fact a distinct drawback, accustomed as he is to exhibiting his handiwork to many. However, wider scope is given the hobby of microscopy by combining it with photography and in this way adding new zest to a branch of scientific work that never loses its interest to those of an exploratory turn of mind.

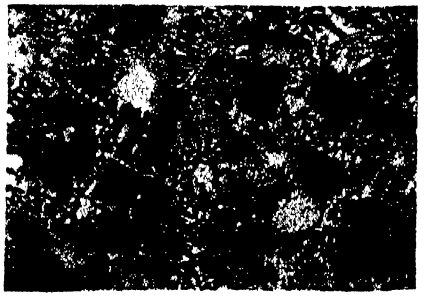
Simplified set-up for photomicrography, described in text at right

Photomicrography is no formidable undertaking that calls for vast scientific background, but may be practiced by any amateur who acquires a liking for this kind of work. Barring a few small adjustments, photomicrography resembles straight photography, and so far as developing the negative and making the print or enlargement is concerned, there is, of course, no difference. The same film you use for regular photography is employed here, too, and the same principles apply also with regard to the chromatic character of the emulsion, orthochromatic being used ordinarily and panchromatic for subjects containing red. To compensate, however, for the chromatic aberration (failure of different colors reflected to come to a single focal point) of the average microscope lens, it is recommended that a filter be used, the ideal all-around filter being a yellow green, one type of which is the Wratten "B." The filter is adjusted in a position between the source of light and the microscope mirror.

The set-up for photomicrography is a camera attached to a microscope outfit in such a way that the camera may be racked up and down for focusing and the lens of the microscope used for photographing as well as viewing the subject. A simple outfit, such as the one recently put out by Bausch & Lomb, offers an easy and inexpensive way to investigate the possibilities of photomicrography. Its low cost will permit the beginner to experiment with it to his heart's content without "plunging" on something that he may later find unsuited to his tastes. Should he take to it like the proverbial duck to water, as is altogether likely, there will be time enough later to decide on the purchase of a more advanced instrument.

The outfit includes a heavy, cast metal base, attached to which is a supporting rod on which the camera support is moved up and down. A focusing tube attached to the side of the camera has a frosted film disk in the upper end in exactly the same plane as the film in the camera. A short metal tube is mounted to the underside of the camera in the place ordinarily occupied by the camera lens, the tube's inside diameter being designed to fit snugly over the eyepiece of the microscope in order that a light-tight connection may be obtained between camera and microscope and to center the camera with the microscope automatically.

The light source for this outfit may be an ordinary 40-watt Mazda frosted bulb in a reflector, the common goose-neck type being considered ideal for the purpose. While the brighter the light the less exposure needed and therefore the less danger from slight vibration, too bright a light may bring the exposure time down so sharply that it will be difficult to control it accurately. Workers who have encountered trouble with excessive light in other



Photomicrograph of an alloy of the stellite type. Magnification 3000x

types of photography will recognize in this a familiar enemy.

Exposure time in photomicrography, as in ordinary photography, is determined by the amount of light reflected from the object as well as the filter factor, the speed of the film emulsion used, and the degree of magnification desired.

The interests that may be pursued through photomicrography take in the

A male dog flea, magnification of 40x; with dark field illumination

world's greatest sciences as well as the humblest, some idea of the scope being gained from the fact that not only may one delve into the mysteries of physics, chemistry, metallography, geology, microbiology, botany, and zoology, but also into those of household objects, textiles, and paper. One may observe and photograph the collection of dark dots and lighter spaces on a small piece of exposed photographic film; study rust on an old piece of steel or iron; explore the contents of a vacuum cleaner; examine pieces of fabrics or a slice of raw potato. In short, the world is your oyster and the joy of it is that if you like the hobby a pearl will be your reward every time.

Very accurate focusing, proper placement of the light source so that the light is transmitted through a translucent subject or reflected from an opaque one as well as being adjusted to cover evenly the entire area of the slide visible through the lens, printing on glossy paper in order to show up every detail, are some of the chief factors involved in photomicrography. The experienced amateur photographer who has never attempted photomicrography will find in it so much that is true of ordinary photography that there will be little to learn except, of course, for those features which relate strictly to microscopy. However, knowledge is relatively cheap—costs no more, in fact, than the price of a book. In this connection, if you like, this department will be happy to send you a list of books on this subject.

Pictures by Moonlight

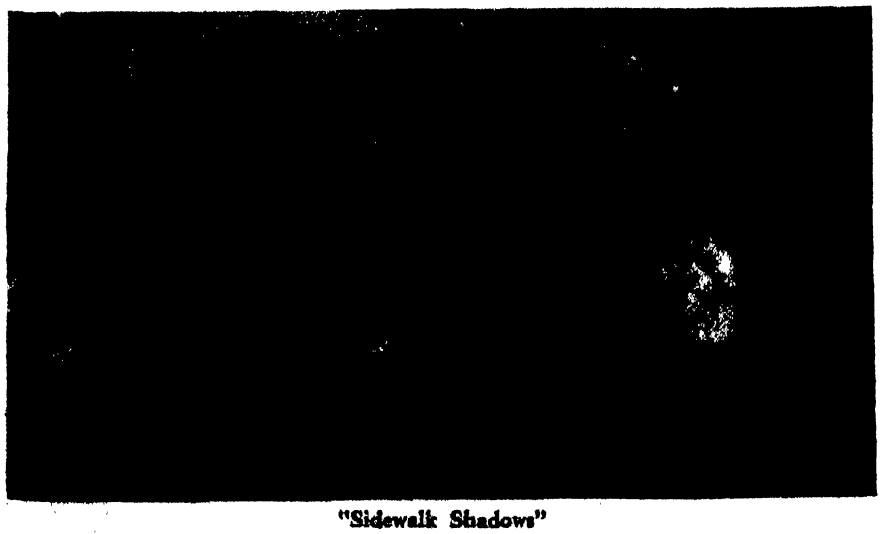
A METHOD of taking photographs by the light of the moon at relatively fast time exposures has recently been introduced abroad by the French astronomer, M. Lucien Rudaux. The fact that moonlight is said to be about 650,000 times weaker to the film emulsion than sunlight makes M. Rudaux's achievement stand out as a most remarkable feat. M. Rudeaux's objective was to find a means of cutting down the long exposure ordinarily required in moonlight photography in order to record such slow-moving objects as clouds. By employing a condenser used in a projection apparatus he obtained a lens of rather large aperture, obtaining definition by the usual procedure of stopping down considerably. He found that a 4-inch condenser stopped down to 2¾ inches gave him a lens of F:1 speed, which was fast enough to bring exposures down to under a minute by the light of a full moon.

Kodachrome for Stills

KODACHROME film, hitherto available only for motion picture cameras, is now announced for stills as well, the sizes for the time being limited to two, roll No. K828 (8 exposures) intended for use in the Kodak Bantam Special, and roll No. K135 (18 exposures) intended for cameras of the Kodak Retina type. The full color transparencies obtained with this film as easily as ordinary black and white exposures are viewed in their original size by transmitted light or projected on a screen in enlarged form.

Sidewalk Shadows

IN the lexicon of the photographer a shadow is one of God's greatest gifts to man. Picture a world without shadows and you see a world without contrast, dull, flat and unphotographable. And among its varied manifestations the shadows seen

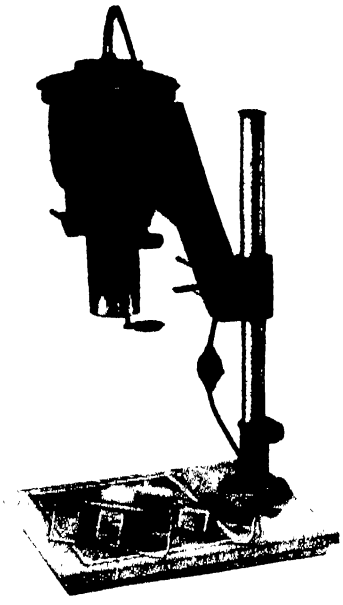


"Sidewalk Shadows"

Use

VERTEX

the Miniature Enlarger



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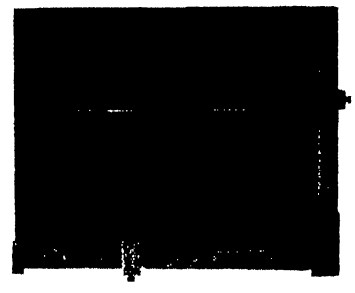

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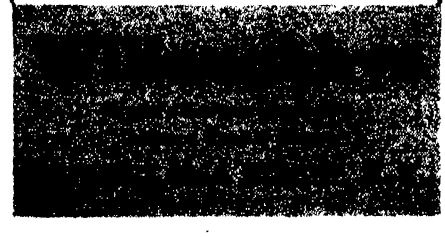

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when the sun is low are the most beautiful and attractive. For long shadows it is generally best to get up high not only to include both subject and shadow in the picture but also to get the most interesting perspective.

Craft Pictures

EVER think of collecting photographs of people in various crafts at their work? If you haven't, here's a thought for you that should lead to interesting personal as well as photographic adventures. You will probably find such old crafts as

"The Puppeteer," a fine example of craft photography. A collection of characteristic poses is worth while

that of the blacksmith, the repairer of violins, the cabinet maker, most productive of pictorial material, and if you will direct your camera to include some such characteristic pose as that shown in the illustration of the puppeteer you will soon assemble a collection that will be worth all the pains involved in making it.

Automatic Enlarger Switch

MORE and more photographic darkroom routine is becoming less and less drudgery. The latest device designed to add to the comforts and conveniences already available for the darkroom worker is the so-called Automatic Enlarger Switch. This instrument, which is equipped with separate switches for time and focusing and powered with a synchronous electric motor, is handsomely encased in Bakelite. The device accurately times the exposure required, which is set by a dial, and automatically lights and turns off the enlarger light.

Toning Simplified

COLOR prints are all the rage these days—and it is conceded that a good color print will always be something to shout about—but direct color photography is still a rather complicated process and one which not all can tackle in the full confidence of achieving success. The toning and staining of prints, however, by which even two or three tones may be obtained, is a simple procedure which anyone can follow. Burroughs Wellcome & Company have been putting out their color producing tablets

BUILD A PHOTOGRAPHIC LIBRARY

Leica Manual, *by Willard D. Morgan and Henry M. Lester.* A beautiful book of over 500 pages dealing with all phases of miniature photography. It covers such subjects as panoramas, photomicrography, dental, stage, and aerial photography, photomurals, infra-red, and many others. $4.00.

Practical Amateur Photography, *by William S. Davis.* Deals with the whole subject from the origin and growth of photography to the latest types and uses of cameras. 264 pages, illustrated. $2.40.

Photographic Enlarging, *by Franklin I. Jordan.* A complete treatise on enlarging, discussing not only the necessary equipment but all of the darkroom processing dodges which may be employed, combination printing, mounting, and lantern slides. It is written in a light yet thorough-going manner. $3.70.

Free-Lance Journalism With a Camera, *by Rufus H. Mallinson.* Many serious amateur photographers would like to know how to make money with their cameras; here is a complete guide to that work. It tells not only how to make salable pictures but also how to market them. $1.65.

The Fundamentals of Photography, *by C. E. K. Mees.* Not only tells how to take and finish pictures but gives a solid foundation of the principles of photography. $1.10.

Portrait Lighting, *by Frank R. Fraprie.* Takes up the rapid development in the last few years of artificial lighting for indoor photography. $2.15.

Modern Development, *by F. R. Fraprie.* Describes all methods of development, stressing particularly modern factorial and thermo methods. All formulas are given. $1.10.

Camera Lenses, *by Arthur W. Lockett.* Explains simply and clearly, yet with scientific accuracy, all the underlying principles of lenses. 85c.

Infra-Red Photography, *by S. O. Rawlings.* A treatise on the use of photographic plates and films sensitive to infra-red. Exposure and processing are fully covered and many formulas are given for sensitizing. $1.65.

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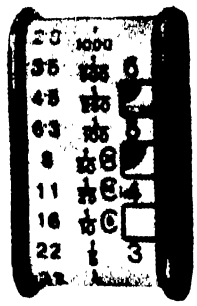

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By Edwin C. Buxbaum, A.R.P.S.

BESIDES having a considerable amount of fun with the miniature camera, making trick "shots," art photographs, and the like, you can also use it for special paying work. This little paper-bound booklet of 72 pages tells not only how to make interesting photographs that are salable to news agencies or magazines but also gives many clues to the very large number of types of photographs that can be sold. For those who wish to mix profit with pleasure this booklet should prove most helpful.—$1.10 postpaid.

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for a long time to the great delight of amateurs everywhere, and their line of toners and stains should answer practically all amateur requirements.

A technically perfect chloride or bromide print, correctly exposed, fully developed, properly fixed and thoroughly washed, is essential. Sepia, blue, and green toners are three popular colors and the brown toner may be used to modify the color of a sepia-toned print. A versatile toner is the Copper Ferrocyanide Toner with which may be obtained a variety of colors ranging from warm black to red chalk, and including various shades of brown, red, and purple. The different colors are realized by varying the period of toning. For most of the toners only one bath and a short period of washing are all the work required.

The stains stain the paper and the emulsion, leaving the black image unaffected and are effectively combined with toners to produce unusual color results.

Projected Backgrounds

WHEN spotlighting the background in portraiture, interpose a cutout between the spotlight and the wall or whatever plain light-toned background you may be using and thereby considerably improve the resulting portrait. Generally, in this type of background, it will be necessary to so light the subject as not to show his or her shadow on the background. The possibilities in this connection, it is readily apparent, are limitless, for not only may one project a design on the background but a whole scene as well. A projected cutout is an excellent means of giving your portraits an individual twist.

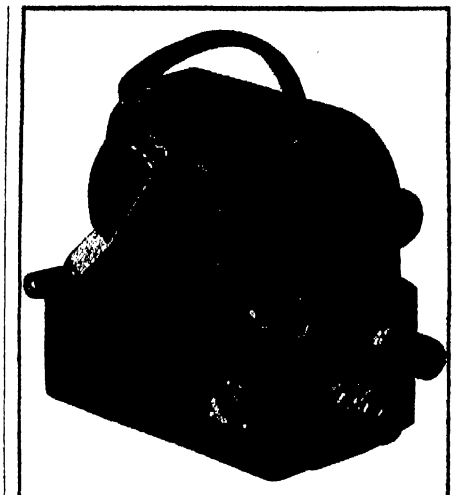
Tray Cleaner

A TIP from the professional on how to clean those stained trays: Dissolve 4 ounces of potassium bichromate in 16 ounces of hot water and add 4 ounces of commercial sulphuric acid. After swishing this solution around in the dirty tray for a couple of minutes, rinse the tray with clean running water. This cleaning solution can be used a number of times.

Write Your Own Title

"SNAPSHOTTER Snapshot!" is this department's feeble first attempt. Or perhaps, since this department is written

"Snapshotter Snapshot!"



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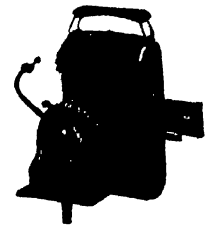

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for photographers, you will prefer Burns'

Oh wad some pow'r the giftie gie us
To see oursel's as others see us!

Anyway, the next time you visit the zoo, why not train your camera eye on your fellow-hobbyists as a change from animal hunting?

Parades

PARADES sometimes offer unusual photographic opportunities and are always worth watching with pictures in mind. "On

"On Guard"

Guard" shows one way of converting an ordinary parade scene into something better. The large form of the police horse's head and neck in the foreground makes for effective pictorial balance, as well as contrasting mood—the ardor of the parade leader and the watchful impassivity of the horse's countenance.

Spraying Photographs on Walls

WORD comes from England of the development of a new type of wall decoration by which any wall surface may be sensitized by spraying it with a photographic emulsion, an image projected upon it by the usual enlarging method, and then the developer and fixing solution sprayed on the wall to complete the printing routine. The whole thing seems fantastic and to the cradle watchers of the last century, who nursed photography until it was well on the way to its present healthy and vigorous state, might have seemed an impossible day dream. But the fact remains that there is no if or maybe about the matter; it has been done and the inventors, Eugene Mollo and Paul Lamboit, are proving it every day.

Mr. Mollo, in describing the process, which, incidentally, is based on a patented formula, sees the new method "a practical and commercial proposition" for decorating large surfaces by means of photography and as greatly enlarging "the decorative possibilities of the photo-mural, for by means of it jointless photographs with a hard washable surface can be produced not only on a flat wall but also on any bas-relief, curved, corrugated, or fluted surfaces."

Making Haste Slowly

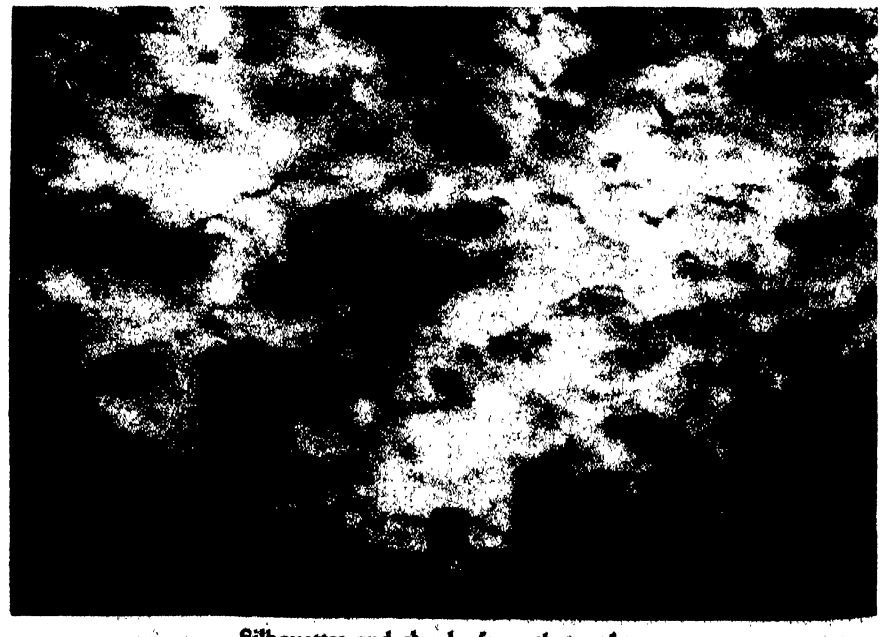
OWNERS of cameras equipped with F:4.5 lenses who have wished on certain occasions for speedier lenses may take comfort in the fact that some workers have been able to overcome the difficulty of "stopping" night action scenes by waiting for the "moment of suspended animation" when action stops for a brief interval. One man recently succeeded in "stopping" a trio of acrobats with a 1/25th of a second exposure at the full opening of his F:4.5 lens.

Carrying Cases

CAMERAS with exposed lenses and range-finders or view-finders should always be protected, when not in use, by a carrying case of some kind or other. Fine leather cases may be purchased, of course, or, with a little ingenuity, you can make your own to your own design and taste. Leather or heavy cloth are suitable materials.

Roof Pictures

MANY of us never get to see the roofs of the houses we live in. And that's a great pity, because there's many a good photographic shot available from a roof-top vantage point. With all proper modesty, this department submits the accompanying illustration as an example of the possibilities.



Silhouettes and clouds, from the roof-top

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 225)

cigar or cigarette butts on a rock or in mineral soil. He does not even throw "dead" butts into brush, leaves, or pine needles. He drops them into the dust of trail or road and tramples them, to be doubly sure they are dead.

The careful smoker not only observes these rules but while traveling through forest, brush, or grassy land smokes only in a safe place where there is no inflammable material, or inside a vehicle with an ash receptacle.

Shorter Syphilis Treatment

THREE Chicago scientists believe that they have succeeded in decreasing materially the long period of treatment necessary for persons who have syphilis in its early stages. They further feel that their methods bring the eradication of the disease in its early stages one step nearer realization.

Dr. Clarence A. Neymann, Dr. Theodore K. Lawless, and S. L. Osborne have merely combined the recognized fever and drug treatments of syphilis, and the results, reported in the *Journal of the American Medical Association*, have been highly satisfactory.

The average time consumed in this combined treatment is 42 days. An average of five sessions of fever were given each patient and an average of five injections of neoarsphenamine were given during the treatment period. A small amount of bismuth salicylate was also used.

Fourteen cases of early syphilis were treated with hyperpyrexia; that is, the patients were given a high fever. Half of them simultaneously were given arsphenamine and bismuth compounds.

The seven treated by fever therapy alone developed further signs of the disease. The seven given the combined treatment have shown no clinical signs of syphilis for periods ranging between five and eighteen months.

"This entire treatment presupposes an organized expert medical and nursing staff trained in giving hyperpyrexia treatments and the hospitalization of the patient during 24 hours for each session of hyperpyrexia," the three medical scientists state.—*Science Service.*

Soybean Adhesives

SOYBEAN meal, after the extraction of the oil used in paint and as a food, contains a large proportion (41 percent) of a protein resembling the casein of milk. This protein is used in making glues for manufacture of plywood; as much soybean glue is used in the United States as of all other plywood glues combined. *D. H. K.*

Perfect White Impossible

PERFECT white exists only as an unattainable scientific standard. All substances filling the layman's conception of whiteness are actually darker, grayer than the perfect white. The nearest colors to the perfect white are those of the purest chalk or a very thick layer of new-fallen snow. But even these fall short of science's rigid standard. The increasingly wide use of the word white in connection with commercial articles, however, especially in advertising, made scientific recognition imperative.

Research to determine a method of grading these varying shades of white was undertaken in the Massachusetts Institute of Technology color laboratory. The results, which constitute the basis of all modern discussions of whiteness, have been explained by Dr. David L. Mac Adam, of M.I.T., who conducted much of the research.

All substances which are ordinarily called white, he told the conference, differ from the perfect white in one of two ways. All are darker, grayer than the perfect white. Some may show no other difference, and these are scientifically regarded as grays of differing degrees of brightness. They are commonly called whites, however, the brighter substances being regarded as whiter than the others.—*Science Service.*

Canada Produces Most Platinum

PLATINUM first became known to Europeans early in the 16th Century when it was discovered with gold in the river beds of what is now Colombia, South America. Later the important deposits in the Ural Mountains were discovered. Then its existence in the copper-nickel ores of the Sudbury district in Ontario, Canada, was noted, and finally it was found that the gold ores of South Africa contained substantial amounts of the metal. Today Canada is the most important platinum-producing country and Russia is second.

More Research—Less Unemployment

LESS unemployment and perhaps no jobless at all would be the state of the nation if industrial research were done by more and better people. This is held to be "perfectly obvious" by Dr. Willis R. Whitney, General Electric's vice president in charge of research, quoted in a *Science Service* report.

Always there is an increasing circumference of untested assets about us and an infinitely fertile area for progress just adjacent to the known. New industries may be put into action at any instant, Dr. Whitney said, by the maturing of some new crop of facts, materializing into gadgets.

Dr. Whitney is himself a leader in applied physics and he was for many years director in the General Electric Research laboratories.

"Is it enough in a research laboratory to tackle known difficulties, to improve output and to analyze competitors' methods and products?" Dr. Whitney said in a Sigma Xi address. "The answer is, no! And this leads to asking how far afield should a research laboratory go. The aims of the research group should include protection of the industry against the sure obsolescence due to new discoveries by someone. Discoveries made entirely outside an industry may disconcert and injure it. They may stop the

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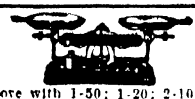

Balance as above with 1-50; 1-20; 2-10; 1-5 and 2-2 gram weights, base 6¾" x 3¾" $1.75. Catalog with 8000 illustrations of laboratory apparatus sent for 50c. Catalog listing 10,000 chemicals, drugs, flavors, etc. and 1700 scientific books sent for 25c Wholesale Price List 1000 ill. 10c.

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earning power of conservatively invested capital. The harness men and carriage builders of the early days were more or less embarrassed by the oncoming automobile makers, because there was little in the harness or wagon business to anticipate the gasoline engine. Research on the old ground is not enough. One must assume that advances will be continually made in all industry, and try to be party to it . . .

"Research is the result of child-like inquisitiveness, and we are likely to check that inquisitiveness, as we do a child's, because we are lazy. It is easier to plan experimental work close to the old home acre, so we do. In electricity, for example, I can think only in terms of wires, magnetic fields, and wavelengths, so I lazily encourage inquisitiveness only about adjacent areas. So much has been accomplished with 25 and 60 cycles and a few selected high frequencies in radio, and even with zero frequency itself, that wavelengths between zero and infinity are subjects for research—simply adjoining fields. But this, too, discloses laziness, ignorance, and conservatism, because I have thought only of the obvious. I may have actually forgotten that I never knew what electricity is, and am ignorant of what it might do if freed from the shackles which limited knowledge has forged. We almost need to provide more 'accidents,' for it is frequently the unexpected effect which drives a researcher into a new and productive field."

A Visit to the "Hindenburg"

We delayed our visit to the *Hindenburg* until its third trip to Lakehurst so as to avoid crowds. Thanks to the courtesy of Captain Anton Heinen (one of the constructors of the *Shenandoah*, now back in service with the Navy), we were privileged to visit not only the passenger and navigation quarters but to walk along the interior keel through every part of the huge ship.

The *Hindenburg* is just as advertised. It is a marvellous piece of engineering in conception and detail. Notes in previous issues have covered the airship rather fully, but we cannot resist setting down some personal impressions.

Seen from below, the engine gondolas look tiny and difficult of access. But when reached through the keel and commodious side walks and gangways, they are found to be roomy and comfortable. The mechanic who is constantly on watch in these gondolas should have little difficulty in his task of maintenance and minor adjustment. It seems a pity that because there is no helium in Europe, the engines have to be placed outboard. In the United States, with our large supplies of helium, we can house the engines inside the hull with much aerodynamic saving.

The *Hindenburg* must navigate with exceeding smoothness since no provision is made for securing crockery, flower vases, or even bottles from sliding or shaking off the tables. A small vessel on the high seas gives the diner infinitely more trouble. The crew eats very well, which is a good omen for the passengers.

When a passenger wishes to leave the smoking room, a bell rings and warns the steward who alone can open the airtight double door. A lighted cigarette near escaping hydrogen is so great a hazard that no passenger can complain of this precaution.

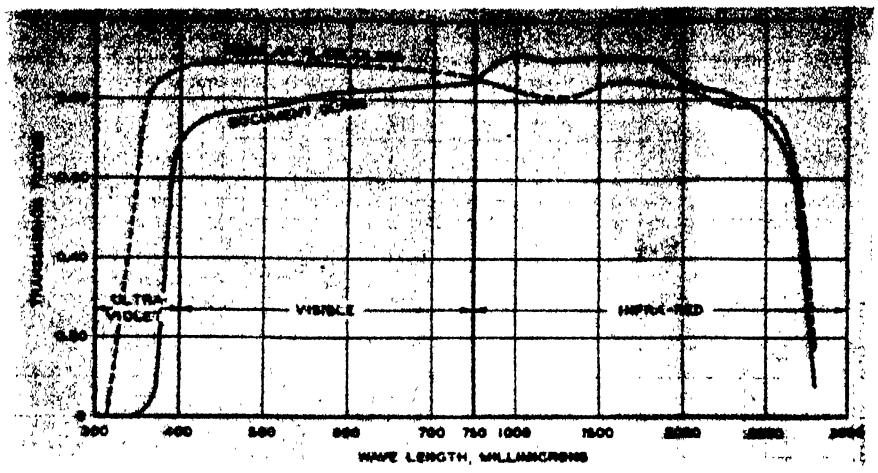
The noise level of the *Hindenburg* is so low that passengers can hear the shouts of people on the ground 500 feet below.

The man who operates the elevator controls in the navigation cabin stands sidewise to the direction of travel; therefore he feels the pitching of the ship and does not have to observe his inclinometer so closely. Elevator man and the steersman are normally relieved of strenuous effort by the interposition of an auxiliary engine, but in rough weather the auxiliary engine is cut out, because manual control is so much more rapid, and because the steersman should "feel" the ship.

Men and officers have the same stamp as men and officers in the merchant marine. Are seamen and airshipmen selected for their steadiness of character, or does steadiness of character develop at sea and in the air?

On the third trip back every imaginable small article was carried on the ship besides mail. But there was one large object. This was the Wright Whirlwind powered Beechcraft biplane, which Mr. and Mrs. James Haizlip, two famous racing pilots, and their son James, Jr. were taking with them to Europe. Mr. Haizlip is the former holder of the transcontinental speed record

Loading a light plane on the *Hindenburg*



Document glass passes but little of the ultra-violet

of 10 hours, 19 minutes. One of our photographs shows the first airplane to be ferried to Europe by airship, while it is being loaded into the hull.—*A. K.*

Soviets Fight Religion With Chemistry

IN the effort of the Soviet government to destroy religion in Russia, many of the experiments familiar to the users of toy chemical sets are being employed, according to Rudolph Seiden writing in *Industrial and Engineering Chemistry.*

Among the experiments shown to young people by the anti-religious lecturers are: turning of water to "blood" by mixing solutions of ferric chloride and ammonium thiocyanate; the transformation of water to "milk" by mixing barium chloride and sodium sulfate; making "wine" from water with phenolphthalein and an alkali; and production of a pillar of cloud with hydrochloric acid and ammonia. Miraculous pictures are made to appear by exposing a cloth or paper previously treated with cadmium, bismuth, manganese, and lead salts to hydrogen sulfide. Fires are made to light themselves by dropping alcohol onto potassium permanganate moistened with sulfuric acid. These and numerous other simple chemical reactions are explained, according to Mr. Seiden, as the way in which the miracles of religion were produced. In America children play with chemical sets and perform similar experiments, but without injury to their religion.—*D. H. K.*

Document Glass

THE production of "document glass," which is designed to protect valuable manuscripts from the deterioration caused by harmful light rays, is announced by the Pittsburgh Plate Glass Company. Developed to meet a growing demand by museum directors and curators of collections of rare manuscripts, document glass filters out the ultra-violet portion of the spectrum, exposure to which causes discoloration of paper and fading of ink, at the same time giving complete visibility by transmitting the visible light rays.

Development of document glass was based on the fact that the ultra-violet portion of the spectrum is most destructive to paper stocks and inks of various kinds, as established in research activities carried out at the Swedish National Testing Institute in Stockholm. The most active light rays are those beyond the range of the visible spectrum in the short-wave region of ultra-violet (shorter than 400 millimicrons).

After considerable experimentation with chemical ingredients designed to transmit the visible light rays and filter out the ultra-violet, document glass was perfected. Comprehensive tests reveal that it transmits only 3 percent of the invisible radiation just out of the visible range, yet has a relatively very high transmission within the visible portion of the spectrum. The chemical elements which give the glass its non-actinic quality impart to it a very faint pink tinge, which in no way interferes with visibility.

With the extremely low ultra-violet transmission effected by document glass—by far the lowest obtainable with any glass of comparable visible transmission—the fading of even the most delicately colored ink and the deterioration of the paper should be almost wholly prevented.

Mothers' Milk for Premature Babies

A NEW process of quickly freezing mothers' milk, thereby preserving it in perfect condition indefinitely until it is needed by prematurely born or seriously ill babies, was recently demonstrated by the Children's Welfare Federation at its offices, 325 East 38th Street, New York City.

The process, invented by Washington Platt, a scientist in the research laboratory of The Borden Company, and worked out in conjunction with Dr. Paul W. Emerson of Boston, makes it possible for the first time to freeze and keep mothers' milk for several months or more, transport it, and feed it to prematurely born or ill babies without the necessity of any subsequent action other than thawing and warming. The process has been licensed to the Federation, without charge, by The Borden Company.

Mothers' milk is regarded by doctors as an absolute necessity for premature babies but their mothers generally are unable to nurse them. This creates a demand which the Mothers' Milk Bureau strives to fill.

Mr. Platt, in explaining the process, said: "Human milk is a much less stable emulsion than cow's milk and therefore the former is more difficult to freeze in such a way that the emulsion will be preserved and the milk remain digestible by infants. It is common knowledge that milk frozen in the ordinary manner, comparatively slowly, has the emulsion partially broken. And it is

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widely recognized by the medical profession that frozen milk may be the cause of digestive disturbances in infants.

"However, numerous clinical tests, particularly by Dr. Paul W. Emerson of Boston, have definitely established the fact that human milk frozen by the new process is entirely suitable for young infants. Our process provides for the freezing of mothers' milk under such conditions that upon thawing the natural emulsion will remain substantially unbroken and the other characteristics will remain sufficiently unchanged so that the thawed product will be suitable for infant feeding."

A study made by Dr. Walter H. Eddy of Teachers College, Columbia University, showed that frozen human milk as compared with unfrozen milk has lost none of its vitamin content. Moreover, frozen human milk does not differ from fresh milk in total solids, fats, carbohydrates, or proteins.

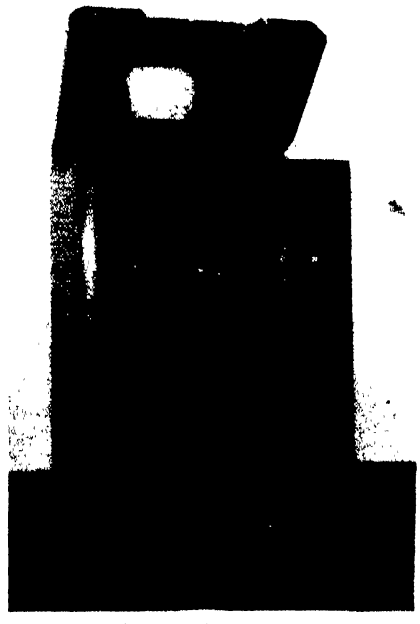
More Television

Television engineers are constantly studying the problems of cathode ray transmitting and receiving equipment. One of the latest demonstrations—in the nature of a progress report—was staged by the Philco Radio and Television Corporation. Using a 345-line picture, they were able to show a reproduced image approximately nine by eight inches in size that gave fairly good definition of the transmitted objects. Indoor scenes under artificial light and exteriors with natural lighting were satisfactorily transmitted by radio over a distance of approximately seven miles.

Although receiving equipment is not as yet available for the general public, the engineers have designed their apparatus along the lines of a standard home sound broadcasting receiver. The images are viewed by reflection in a mirror located in the slanting top of the console cabinet. These receivers are designed for reception of both sound and television signals and contain 36 tubes exclusive of the cathode ray tubes. It is estimated that if and when such receivers appear on the market, they will retail for approximately 500 dollars. This, however, cannot take place until satisfactory transmission facilities are made available and programs have been worked out.

Much of the experimental work being conducted today is directed toward the solution of problems of transmission and toward a study of reception under varying topographical conditions. Because of the extremely short wavelengths used for transmission, it is necessary that everything possible be found out about the actions of these waves in cities, towns, and country, before definite plans can be made for the erection of permanent transmitting stations.

In spite of the development work being done, it appears that the statements made in the editorial on page 9 of the July 1936 issue of Scientific American still hold good.



Above: **Front view of an experimental television receiver.** *Right:* **Rear view, showing self-contained equipment.** *Upper right:* **Television image (reduced) as seen in mirror**

Ephebogenesis

The discovery that ephebogenesis—reproduction with only male cells present—is perfectly possible in nature, has recently been demonstrated by Dr. E. Newton Harvey, Princeton biologist. Parts of the eggs of sea urchins which contained no female nuclei were found to be capable of development by whirling into living organ-

Centrifuge-microscope that proved ephebogenesis possible in nature

isms in a new centrifuge microscope developed in the laboratories of Bausch & Lomb Optical Co.

This "cell carousel" is a rotor mounted on the shaft of a fast electric motor. Inside the rotor a system of microscope optics and prisms has been built to reflect light up into the eyepiece. At 10,000 revolutions per minute the light impulses reaching the eye are of the order of 1 300,000 of one second, but repeated 10,000 times a minute the impulses give the impression of a continuous image.

The force developed by this centrifuge is 12,000 times that of gravity. In other words, one ounce placed at the location of the specimen slide on the periphery of the rotor and traveling with a speed of four miles a minute produces an outward pull of 12,000 ounces, or 750 pounds. As the cell is whirled, the molecular particles are separated according to their specific gravity. The action on the cell results in an acceleration of the process of sedimentation.

Sets Type on Film

A MACHINE which will produce automatically photographed lines and columns of reading matter on film, for printing by lithography or rotogravure, without the intermediate use of type, has just been patented.

Commercial lithography and rotogravure are processes which employ metal plates on which the text matter had previously been photographed. In order to obtain such a plate the required reading matter must first be set up, or cast, in type and a proof pulled to obtain a copy on paper. This copy is then photographed on a film and the film transferred to the zinc plate.

To set up type for the purpose of printing a single copy—which is all that is required—is costly and time-consuming and is an item of major expense in lithographic and gravure printing. The new machine entirely eliminates type and type-casting from the process and produces directly, by photographic means, justified lines or columns of text without the need of a "first copy" printed from type. It accomplishes this by using some of the principles of the linotype machine invented by Mergenthaler, the 50th anniversary of which invention is being marked during the current year.

In the Mergenthaler linotype a line of individual molds or matrices bearing engraved type-characters is assembled and the recesses filled with liquid metal. The metal is allowed to cool, the matrices removed and the result is a "line o' type" composed of the characters engraved on the matrices. In the new machine, the photo-linotype, the engraved matrices are replaced by matrices bearing type-characters suitable for photographic reproduction and a camera device is substituted for the metal-casting mechanism.

In operation, the machine, instead of producing cast lines of metal type-characters on bars or slugs, produces photographed lines of type-images on a roll of film. Because the operations of the machine are automatic and the film may be of any length desired, it is possible to set up, if necessary, the composition of an entire book on a continuous roll. The film, which carries the photographed type-text, takes the place of the "first copy" which heretofore had to be printed.

The photo-linotype offers many other advantages to lithography and rotogravure, such as the ability to obtain many sizes from one size of matrix and various designs of type-faces by the use of screenings. It is believed that the machine will reduce materially the cost of these processes of printing.

The photo-linotype is the invention of Samu-El Ish-Shalom, a typographic engineer, and Dr. Otto I. Bloom, a New York physician.

The Science of Breath

WHEN Dr. J. McKeen Cattell became professor of psychology at the University of Pennsylvania in 1888, he was the first occupant of the first chair of psychology in any university.

The word psychology, of Greek origin, means literally "science of the breath," and was given that meaning because the Greeks associated the breath with life itself. When they observed the breath leaving the body of a dying person, they felt that with it went the soul. So the science of breath meant the science of the soul.

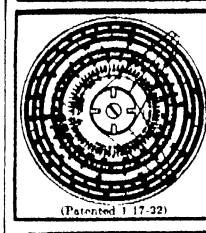
Later when the soul came to have a different and more specifically religious meaning, psychology was called the science of the mind. Still later it became known as the science of consciousness. Much more recently it has been proposed that it should be called the science of behavior.

This development of the term psychology suggested the following witticism quoted by Dr. Samuel W. Fernberger, of the University of Pennsylvania, in his new book on "Elementary General Psychology."

"Psychologists first lost their breath, then they lost their soul, then their mind and now, with the developing interest in reactions, they are rapidly losing consciousness."—*Science Service.*

Accurate Naming of Colors

USING the Munsell system of color description by cable, a week is saved to American fashion designers in duplicating the latest colors of Paris fashions. Colors can be more accurately described for commercial purposes by those characteristics which the human eye recognizes than by the more exact methods of spectrophotometry, according to Walter M. Scott of Gustavus J. Esselen, Inc. The eye readily differentiates



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hue (the position of a color in the spectrum), value (the net relative reflective power of the color as compared with mixtures of pure white and pure black), and chroma (the strength or depth of the particular hue). The system of color specification or description developed by Munsell defines these three characteristics by simple numerals and letters in such a way that anyone with a little experience can readily duplicate any color from its Munsell value. Pink may be accurately described for purposes of duplication by the symbols 5R8/2, indicating that its hue is 5R, its value 8, and its chroma 2. These symbols, widely used in the textile and printing industries, specify an exact color and only one. —*D. H. K.*

Rodent and Bug Chiselers

IRON bars may imprison a tiger and a screen may stop a fly, but some insects and animals are equipped with chisel-like jaws and teeth which can cut through metal.

California lead-cable borers, for example, often damage aerial telephone and high-tension lines in or near forests by boring holes in the lead sheathing. They do not eat the lead. They bore holes in it to establish new homes. Then moisture usually short-circuits the electric current. Linesmen for telephone and power companies call the borer "the short-circuit beetle."

Many other wood-boring insects easily chisel their way through lead and tin signs which block their passageways and exist on trees, according to entomologists of the Department of Agriculture. Hickory bark, which is even harder than most lead and will often deflect the blow of a sharp ax, isn't too tough for hickory-bark beetles. They bore through the bark rather readily. The sharp jaws of Lyctus beetles, often found in seasoned hardwood lumber, enable them to eat through certain kinds of tin and lead which block their passageways. Termites, in biting wood, grind it into a powder.

Rodents occasionally use their hard, sharp teeth on metal. Curious squirrels sometimes gnaw aluminum identification tags off trees. The ground mole sometimes gnaws into concrete, and cases of rats cutting lead pipes in buildings are not uncommon.

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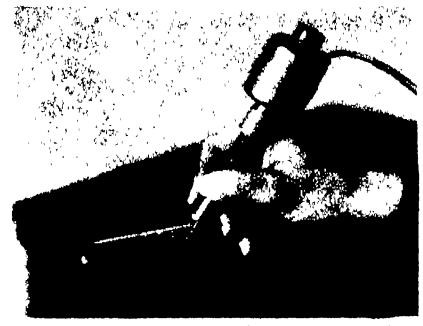
The Ideal Electric Marker is 6¾ inches overall, weighs two pounds, and is as easily handled as a pencil or crayon. In fact it resembles an enlarged pencil with a small



Writing on metal with new "pencil"

motor where the eraser should be. It requires no cabinet, auxiliary controls, rheostats, or transformer for operation. The point does not stick in the marking surface. It makes permanent lines, cut into the surface, that can not be removed by ordinary wear and tear of handling.

This new marker operates on 110 volt, 60 cycle current, and consumes approximately 75 watts. It can be furnished for other standard voltages and frequencies.

Continuous Production of Mirrors

AS a result of the application of a new continuous process to the silvering of mirrors, many parts of the operation are shortened and better mirrors produced. The old process of hand-leveling the glass to receive the solution from which silver is deposited has been eliminated by the use of a carefully leveled conveyor belt. Backing of the deposited silver layer with shellac and quick drying paint has been replaced by a method of mechanically depositing copper directly on the silver. The whole operation requires about half an hour and handling of the plates has been reduced to a minimum to prevent scratching.—*D. H. K.*

Sun Lamps

IN 1927, the National Bureau of Standards published the statement that, of all the artificial illuminants tested, the carbon arc is the nearest approach to sunlight in spectral-energy distribution.

This statement of an observation that was already known in a general way is, of course, not an endorsement of any make of lamp by the National Bureau of Standards, yet this brief and incomplete item was seized upon for sales promotion of carbon-arc lamps. The Bureau, therefore, in Technical News Bulletin 140 (December 1928) issued a supplementary statement on *"The carbon arc versus sunlight,"* in which it is pointed out that while it is true that, of all the artificial sources available, the spectral radiation from the carbon arc is the closest approach to sunlight, even this source is far from being an exact match of sunlight in spectral intensity. It contains ultra-violet radiation of very short wavelengths and infra-red rays of long wavelengths which are not found in sunlight.

By covering the carbon arc with a screen

of special glass it is possible to shut out the ultra-violet of short wavelengths and infra-red rays of long wavelengths. Nevertheless, there remains a selective emission band of ultra-violet radiation (the "cyanogen band"), the intensity of which is far in excess of that observed in sunlight.

For some years sales-promotion literature containing quotations from the 1927 statement has been in abeyance. Recently this incomplete statement from it, with no reference to Technical News Bulletin 140, has been revived in advertisements of "health lamps" and "sun lamps," with the inevitable result that the Bureau receives repeated requests regarding the reliability of the claims made for such lamps—including carbon-arc and tungsten-filament lamps.

The Bureau wishes, once more, to call attention to the fact that without an elaborate combination of filters no artificial source of radiation has yet been devised, and there is, consequently, no lamp on the market that has a spectral-energy distribution identical with that of sunlight. Moreover, in purchasing any lamp, its spectral-energy-distribution curve is not the only thing to be considered. Hazard from fire and from burns, which may result from contact with the housing of the lamp, as well as the possibility of generating disagreeable odors should all be carefully investigated.—Abstracted from the *Technical News Bulletin* of the National Bureau of Standards.

Better Hectographs

GELATINOUS plates or rolls used in the hectographic copying process are made by a new method patented by Erik R. Nielsen of the Miner Laboratories, Chicago, to meet service requirements better than has been possible in the past. The mass, which is made of glue, glycerol, and water, is made alkaline before the addition of small amounts of formalin which harden the mass. Accurate adjustment of the alkalinity and the amount of formalin introduced enables the maker to provide a mass of high melting point for summer use or greater softness for use in winter. The character of the mass determines the number of copies that can be made from it. Longer life and copies of any degree of brightness are realized by using the new method.—*D. H. K.*

Pillow-Block In Rubber Housing

THE latest step in conquering friction and vibration in shaft bearings is a "floating" pillow block. A molded housing

Rubber cushions a shaft bearing

of solid rubber supports a standard ball-bearing unit in which shafts turn smoothly at high speeds. The bearing itself is of the sealed pre-lubricated type. After it is pressed into the rubber housing, a rubber washer and thrust collar hold it tightly and permanently in place. On the outside, a special lacquer protects the surface of the rubber from deterioration.

The new construction is said to provide quieter and more shock-proof operation than is obtained with the ordinary cast iron housing, for the same reason that rubber mountings for automobile engines have achieved success. In addition, it is reported to be less expensive. Its initial application has been to fans used in domestic heating units of the forced air type, but numerous other possibilities exist for supporting high-speed shafts where loads are light but noise and vibration are a problem.

SIX—COUNT 'EM

NOW on the market are six so-called synthetic rubbers, most of which have certain characteristics making them superior to natural rubber. They are: Thiokol, Koroseal, AXF, DuPrene, Plioform, and Tornesit. The last two are rubber derivatives.

Safety in Using Carbon Tetrachloride

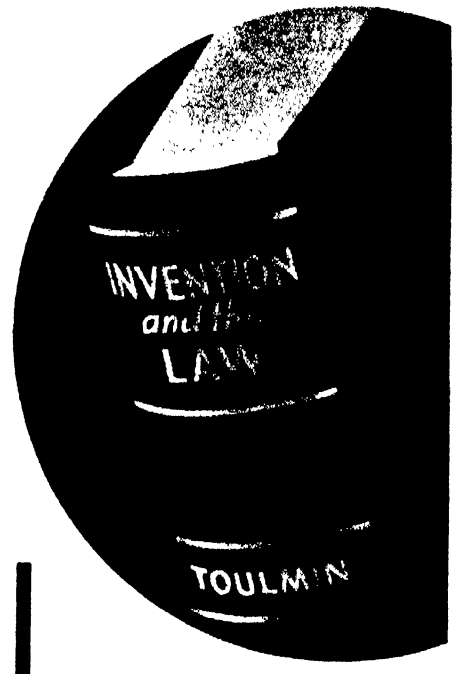
INCREASING use of non-flammable synthetic solvents in the dry-cleaning industry has suggested fears that workmen may be endangered by exposure to vapors of the solvents used. One of the most important of these solvents is carbon tetrachloride, familiar through its use in fire extinguishers.

An investigation conducted by the Laboratory of Hygiene, Philadelphia, under the sponsorship of five leading manufacturers of carbon tetrachloride, has recently been reported to show little reason to fear poisoning of workers if simple precautions are taken. Some 96 men working in contact with the vapors of carbon tetrachloride showed no serious or unmistakable injury traceable to the exposure. Further extensive investigations with guinea pigs, white rats, and monkeys showed that no injury is caused by concentrations that can be readily smelled and that there is some doubt about the injury caused by concentrations even ten times as great.

The recommendations based on the results of this study state that standard dry-cleaning units now on the market for use with chlorinated solvents are safe and that it is possible in practically any industrial use of carbon tetrachloride to keep its concentration in the air below the safe level of 100 parts per million. Ventilation can readily keep concentrations within safe limits. No cumulative effects from the vapors were found but the report points out that some rare individuals may be found whose resistance is less than normal and who should not expose themselves to carbon tetrachloride vapors.—*D. H. K.*

Rescue 230,000 Fish

WHEN the Sinking Pond near Muscle Shoals City, Alabama, recently staged the disappearing act, for which it has become famous and by which it earned its name, nearly a million fish were left strand-



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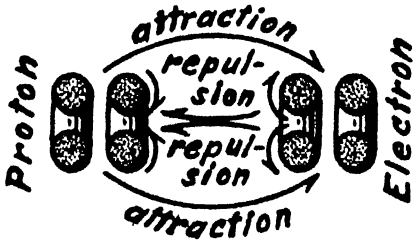

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ed, according to a bulletin of the American Wildlife Institute, Washington, D. C. But the energetic work of Commissioner Quinn's cohorts, reinforced by local sportsmen, saved over 230,000 of them.

It has been three years since the last retirement of this strange body of water. At that time, 165,000 fish were reclaimed. But the water came back and so did more fish, apparently from the depths of the ground. Geological experts believe the water comes from a subterranean arm of the nearby Tennessee River which is approximately 100 feet lower than the pond level. Authorities of the Geological Survey state that this is a limestone region which is relatively porous and subject to peculiar reaction to underground water levels. In wet weather the water level rises and the pond is probably formed at that time. In dry summers, with the lowering of the water table, the pond sinks into oblivion almost overnight.

But come and go it does, and so do the fish, as Game Warden W. M. George will attest. Watching and worrying about this has grayed his hair. If it would only give him a little more notice it wouldn't be so bad. But it takes its departure quickly, quietly, with little ado and never an "adieu".

This year Warden George and his men started on Sunday and worked all week hauling out 175,000 crappie, 40,000 bream, and 15,000 bass ranging from one inch in length to three pounds in weight. There ought to be medals for everybody who worked on the project.

Without Soil

CALIFORNIA nurserymen are growing vegetables and berries in chemically treated water heated by electricity. The idea has been taken from the laboratory at the University of California where Dr. W. F. Gericke has pioneered and developed nutrient plant solution agriculture. Commercial growers in Capitola, Los Angeles, Watsonville, and Richmond, California, are using the water basin method for raising tomatoes, sweet peas, and strawberries.

Water-filled vats, on the bottom of which are electric heating cables, are covered with mesh chicken wire. Excelsior, sawdust, or suitable litter spread on the wire serves as seedbed and insulation against heat loss. Plants or seeds are placed on the bedding, kept moist by water in the basins. As the plants grow, the roots enter the water. Then necessary chemicals are added as fertilizing units supplying the elements, each in proper form and concentration, for the use of plants. The chemically treated water is kept at the proper temperature by the heating cable.

Dr. Gericke is continuing his experimental work in growing tobacco, cucumbers, papaya, and floral crops in chemically treated water.

General Electric engineers, called in when Dr. Gericke needed a controllable heat source, supplied heating cable for the doctor's work and also for commercial installations under his supervision, which have sprung up in California as a result of the new method of controlled crop production.

According to Dr. Gericke, nurserymen have put tomatoes of unusually high quality on the market ahead of their competitors, who used soil to grow their crops. The yield, he said, was large and commanded a decided premium on the market.

The California installations are operating at present under Dr. Gericke's supervision, because cultural technique must be adjusted to meet climatic conditions.

GETTING THE BIG FELLOWS OVERBOARD

(*Continued from page* 194)

out with large centrifugal pumps. The ship is left standing on blocking which has been arranged to receive her. It is naturally possible to build a ship in such a dock and to float her by the simple expedient of flooding the dock, opening the gate, and towing her out. The objection to the method is purely economic. Dry docks are expensive to build and maintain. Interest and depreciation charges on a dock utilized for shipbuilding normally become part of the cost of the ship. In many cases, these charges would exceed the considerable cost of launching the ship, plus interest and depreciation charges for building ways.

The launching of a ship built in a dry dock is a singularly unimpressive ceremony. Water is admitted to the dock and when the ship floats, or when she starts out of the open dock gate, the sponsor christens her. That's all there is to it.

The custom of ceremoniously christening a ship at the time of her launching is a very old one. An Assyrian tablet found some years ago gives an account of the building of the Ark and describes the religious ceremony, including the sacrifice of oxen, which marked the completion of the vessel. Some form of blood sacrifice usually marked the launching ceremonies of the vessels built by the savage inhabitants of the Pacific Islands, the Chinese, the Phoenicians, and the Egyptians. With the advancement of civilization, the blood sacrifice was abandoned in favor of pouring a libation of wine on the vessel.

In England, where most of our naval and maritime customs originated, ships of the ancient Royal Navy were christened by a prince of the ruling house who was stationed on the poop and poured wine on the deck and named the ship as she entered the water. Not until the Nineteenth Century did a woman christen a British man-of-war. Nowadays the sponsor is usually, but not always, a woman. A notable exception was the christening of the Canadian Pacific liner *Empress of Britain*, the Prince of Wales, now Edward VIII, being the sponsor.

It is well known that an old nautical superstition attributes bad luck to any vessel not properly christened. For this reason, considerable care is taken to insure the wine bottle breaking when it hits the bow of the ship. In spite of all the last minute lectures delivered to nervous sponsors on the strength of wine bottles, it is occasionally necessary for someone to lend a hand to insure the bottle actually being broken.

The battleship *New York* almost got away unchristened at the New York Navy Yard when launched in 1912, and only a short time ago at the same yard, the bottle failed to break the first time it was swung against the stem of the gunboat *Erie*. Incidentally

the determination of one sponsor to *break that bottle* had an amusing result. The girl had been so impressed with the necessity of hitting the bow a mighty swat that she literally thought of nothing else. The triggers were released, the ship began to move, down came the sponsor's good right arm and smash went the bottle into a thousand fragments. She broke the bottle all right, but she never said a word!

Anything can happen at a christening! At the launching of a small yacht at a southern yard a good many years ago, I well remember seeing the sponsor run down the ways after the boat belaboring the bow with a champagne bottle. She finally hit the iron stem band with the bottle and broke it, but we told her afterwards that the name she gave the boat was the "Oh! My Lord, it won't break!"

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

COPPER WIRE TABLES, Circular C31, National Bureau of Standards, is a reprint of a publication which has not been available for several years. It deals with such things as electrical resistivity, temperature coefficient, and density of copper, as well as wire gages. *Superintendent of Documents, Government Printing Office, Washington, D. C.—20 cents.*

AUTOMOBILE FACTS AND FIGURES, 1936 Edition, is of particular interest to any one connected with the automotive industry. It gives statistics regarding such phases as production value, gasoline tax receipts, registration tax receipts, raw materials, state highway expenditures, and so on. *Automobile Manufacturers Association, Inc., 366 Madison Avenue, New York City. —Gratis.*

SILTING OF RESERVOIRS, Technical Bulletin 524, Department of Agriculture, emphasises the fact that cleaning of water and power reservoirs is too expensive a proposition and the only solution is to stop erosion and keep out the mud. The bulletin tells of work that has been done in attempts to make this possible. *Superintendent of Documents, Washington, D. C.—40 cents.*

29 WAYS TO PLAN A BASEMENT gives this number of basement plans as well as perspective drawings, predicated upon the use of a heating plant that makes cellar areas available for recreational and similar purposes. *Write for Bulletin 1036A, Scientific American, 24 West 40th, New York, N. Y.—3-cent stamp.*

THE PHOTOPLAY AS LITERARY ART by Walter Barnes, Ph.D., is a 40-page pamphlet particularly concerned with the promotion of an appreciation of the work of the motion picture. It also makes a strong plea for a continued trend toward better photoplays. *Educational and Recreational Guides, Inc., 125 Lincoln Ave., Newark, N. J. Single copies 50c; quantity prices on application.*

PLASTICS, National Bureau of Standards Circular 411, describes four principal types of organic plastics—synthetic resins, natural resins, cellulose derivatives, and protein plastics. *Superintendent of Documents, Government Printing Office, Washington, D. C.—5c.*

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CONCENTRATION OF COPPER ORES IN NORTH AMERICA, by Thomas G. Chapman, Bulletin 392, United States Bureau of Mines, summarizes and discusses copper-concentrator methods, results, and costs from 1929 to 1931, and includes an account of trends and developments in the industry. 169 pages, 26 illustrations. *Superintendent of Documents, Government Printing Office, Washington, D. C.—15c.*

OUTLINE OF THE HISTORY OF THE UNITED STATES PATENT OFFICE is a special number of the Journal of the Patent Office Society published in commemoration of the 100th Anniversary of the Patent Act of 1836. The book, 234 pages, covers the "Origin and Early History of Patents," "Colonial Monopolies and Patents," the Patent Acts of 1790 and 1793, the Act of 1836, and legislative changes since that time. It also deals historically with the Patent Office itself, and with the Commissioners of Patents. *Journal of the Patent Office Society, United States Patent Office, Washington, D. C.—$1.00.*

THE COLORADO DELTA, by Chas. Kirby Fox, Am. Soc. C. E. The author fears that the accumulating silt behind Boulder Dam will load the earth's crust and act as a trigger effect to set off serious earthquakes. *Chas. Kirby Fox, 1314 Washington Bldg., Los Angeles, Calif.—Gratis.*

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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The Natural Supply of Frogs Rarely Equals the Demand for This Epicurean Delicacy; Raising the Frogs in Captivity Offers a Solution

THE newspapers have made the public familiar with the great disk of Pyrex glass cast at Corning, New York, and transported to California, there to be slowly converted by grinding and polishing into the huge 200-inch "eye" of a telescope far larger than any now in existence. On the cover is shown the great dome under which the telescope will be housed—its height will be 135 feet. In the drawing, Russell W. Porter has indicated an airplane landing in front of the dome, where there will be a landing field. Some of the astronomers will "commute" to this observatory by airplane.

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50 Years Ago in . . .

Scientific American

(Condensed From Issues of November, 1886)

DRINKING—"Science may be carried into everything. The science of drinking has been known and practiced in Europe for ages, and this is a science, simple as it may appear, when compared with the blind, irrational, and suicidal manner of drinking in the United States. This science consists simply in the tardiness of drinking. All drinks are taken sip by sip, a half or three quarters of an hour being consumed for a glass of beer. . . . By slow drinking the German accomplishes the object of drinking, and gives his animal economy a chance to say, 'Hold, enough!' which only slow drinking will do. . . ."

VENTILATION—"The fundamental conditions that are necessary in order to have a healthy habitation may be summed up as follows: (1) that of having fresh air to breathe amid walls and furniture kept at a proper temperature; (2) that of receiving the full light of the sun, and of having the objects about ourselves amply lighted; and (3) that of having no dejections remain in the house."

BESSEMER CONVERTERS—"At a recent meeting of the Iron and Steel Institute, London, Mr. James P. Witherow, of Pittsburgh, whose converter had been described by Mr. Hardisty, said that in America, within the past two years, considerable headway had been made in the development of the Bessemer process with the fixed or stationary type of converter."

AUTOMATIC TRAIN STOP—"The purpose of this attachment is to prevent accidents and collisions by a more effective safeguard than has heretofore been devised. . . . Attached to one side of the cow-catcher of the locomotive is a three-way cock, the lever for operating which projects at one side, so that an obstruction placed alongside of the track will operate the cock as the locomotive moves past. The movement of this cock . . . applies the brakes . . . operates the throttle valve . . . opens the sand valve for sanding the track . . . rings a gong bell placed within the cab and . . . opens the valve of the steam engine."

PREHEATING—"The steamship Bleville, of Havre, recently built and engined by Messrs. Alex. Stephen & Sons, of Linthouse, is a steel screw steamer, 300 ft. long, and is fitted with triple expansion engines of 210 N. H. P. The principal novelty is in the design of the boilers. In the uptake of these . . . tubes are so arranged that the water, before it enters the high temperature boiler, is heated by the gases from the fires, which would otherwise be lost."

PETROLEUM ENGINE—"To produce a small engine that can be operated by the combustion of petroleum is a problem that has received the attention of quite a number of our best inventors." In one of the latest engines, "the petroleum is stored in a tank containing one to two days' supply, as the case may be. A small pressure of air is put into this tank and the petroleum is forced out of it into a vessel in a vaporized condition, from which it is then drawn into the cylinder by the outstroke of the piston; and having been compressed on the instroke, the charge is ignited by means of a small electric spark."

STEEL PIPE—"It is reported by the Berlin *Eisenzeitung* that the new process for making steel pipes employed at Burbach is very successful. . . . As soon as the steel is cast into the round mould, a core is thrust into the steel, so that a tube is formed between it and the walls of the mould. In order to prevent cracking of this annular casting during cooling, the core is so made that it follows up the shrinkage of the steel. The steel cup thus obtained may then be rolled in an ordinary train."

DOUBLE DREDGER—"The engraving represents one of Priestman Brothers' double self-contained dredgers, and is taken from a photograph, in South American waters. The dredger is somewhat novel in its construction, being the first of the kind which has been made. A large steam hopper dredger has been fitted with four of Priestman's machines, made to the order of the Mersey Docks Board, and can be seen working in Liverpool or Birkenhead docks; but this particular dredger, although suitable for all kinds of dock and harbor work, was specially designed for exportation. It forms part of an order for the Brazilian Government for carrying out harbor improvements in the port of Maranham."

CRATER LAKE—"Captain C. E. Dutton, of the U. S. Geological Survey, has been recently engaged in making a study of Crater Lake, in Oregon, and the latest advices received from him show that he has discovered probably the deepest body of fresh water in the country."

WHITE PAPER—"Many believe the eyesight is impaired by the use of white instead of colored, or at least tinted, paper, and at times the subject comes up for discussion. So far as we have seen, no positive evidence has yet been secured to prove the injurious effect of white paper on the eyes, and some recent inquiries lead us to doubt if such evidence is to be had."

TORPEDO CANNON BALL—"The *Avenir Militaire* gives us some particulars concerning a torpedo cannon ball invented by Captain Coudray, of the navy. . . . The torpedo cannon ball . . . travels at the rate of 300 meters a second, and instead of rebounding on striking a ship, glides along its side, and never loses contact until it explodes. The last cannon balls constructed contain a charge of 40 pounds of guncotton, although 25 pounds is said to be sufficient to blow up the biggest vessel. It is stated that these projectiles can be fired to a much greater distance than the Whitehead."

THE NEW NORTH—"The country north of us is not all Arctic. Those who know best, hardly realize how vast is the new domain of arable land which has just been opened by the completion of the Canadian Pacific Railroad, and how much more remains yet to enter. A new north, vast in resources of all kinds, stands ready for occupation."

PAPER CLOTH—"The Japanese Government paper mill is manufacturing pocket handkerchiefs and clothing of paper pulp containing a mixture of linen threads."

AND NOW FOR THE FUTURE

- British "Mosquito Boats," by Dr. Oscar Parkes
- The Steam Locomotive Meets Competition
- Motor Cars for 1937, by A. P. Peck
- Indium—A Metal Aristocrat
- Modern Home Heating, by Philip H. Smith

Personalities in Industry

DAVID SARNOFF

"IMPRESSIVE as the past and present of radio may be," says David Sarnoff, "those of us in close touch with its developments are infinitely more inspired with the prospects of its future."

The sentence is typical of the man who, at 45, head of the Radio Corporation of America, has already crowded several lifetimes of achievement into a single youthful career. Unlike the Alexander who mourned because there were no more worlds to conquer, Sarnoff envisages the day when radio's services of sight will parallel those of sound, and when every new-born babe may receive a life-assignment of an individual billion-cycle radio frequency.

These are not poetic fancies. They are the considered, well-informed opinion of an intensely practical man, one who has known poverty, hardship, and struggle, and has risen to direct the destinies of 25,000 employees and a world-wide enterprise.

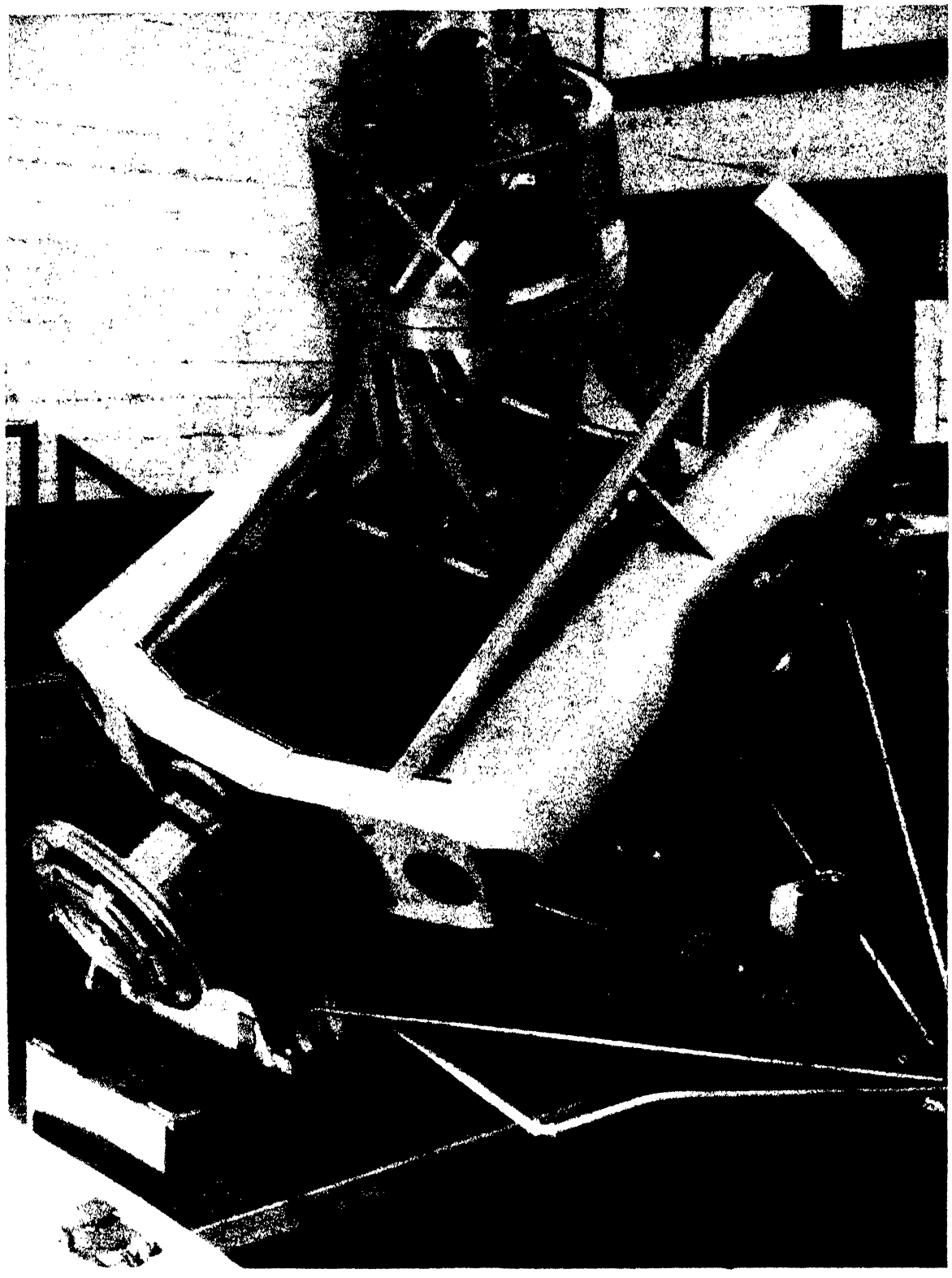
That "America, the land of opportunity" is no idle phrase is perhaps better proved by the career of David Sarnoff than by that of any other living man. Born in Russia in 1891, the eldest of five children, he was brought by his parents to the United States at the age of nine. At fifteen the death of his father necessitated his going to work. He got a five-dollar-a-week job as messenger boy with the Commercial Cable Company, and supplemented his earnings with a newspaper route. He bought a telegraph instrument, learned the Morse code, and on September 30, 1906, fascinated by the new-fangled wireless idea, entered the employ of the Marconi Wireless Telegraph Company of America as an office boy. The fascination did not wear off. He bought technical books, spent his week-ends in the experimental shop of the Marconi Company, and later took a night course in electrical engineering at Pratt Institute, Brooklyn.

Sarnoff soon became a full-fledged wireless operator, and in five years gained expertness and a practical store of technical knowledge in various posts, ashore and on shipboard. When the *Titanic* sank in 1912, Sarnoff stayed at his key in the Wanamaker station in New York for 72 consecutive hours, helping direct the ships that succeeded in rescuing a third of those on board, and obtaining names of the rescued.

The loss of the *Titanic* and the aid rendered by radio aroused public consciousness to the importance of this new service. Congress passed a new law making much stricter the requirements regarding equipment and operators on sea-going vessels. Sarnoff became successively: Chief Inspector, Assistant Chief Engineer, Assistant Traffic Manager, and, in 1917, Commercial Manager of the Marconi Company. In 1919, when the Radio Corporation of America was formed, it acquired the American Marconi Company and appointed Sarnoff Commercial Manager. He progressed steadily from Commercial Manager to General Manager, Vice-President, Executive Vice-President, and finally, in 1930, at the age of 39, to President of RCA.

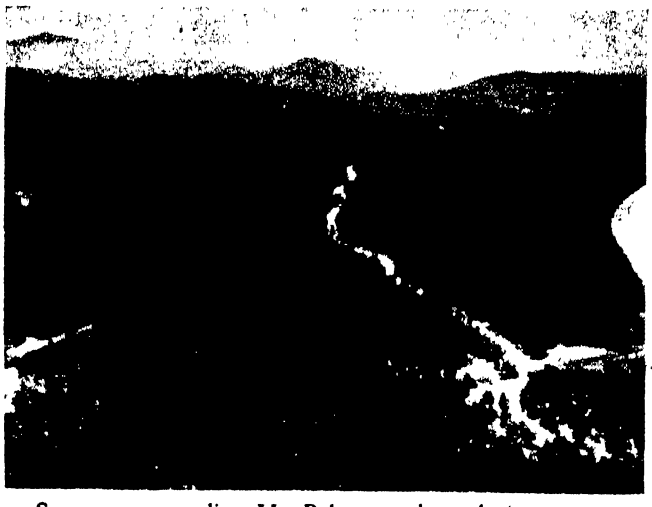
Sarnoff's favorite hobby is good music; his favorite vice, a good cigar. He is a director and member of the executive committee of the Metropolitan Opera, to mention only one of a dozen or more affiliations with important scientific or civic bodies. A Colonel in the Signal Corps Reserve of the United States Army, he is keenly aware of the military and naval implications attached to every fresh advance in the radio art.

That the next conspicuous advance is to be the introduction of television on a commercial scale seems probable. Sarnoff has brooded over this troublesome infant through many years of laboratory development. In 1935 he obtained from his directors a million-dollar appropriation to take television out of the laboratory and give it the benefit of exhaustive engineering field tests under actual service conditions. Television is now moving slowly but surely through this phase of its progress toward its waiting public. Once it has arrived, the imaginative David Sarnoff can check off another dream come true.

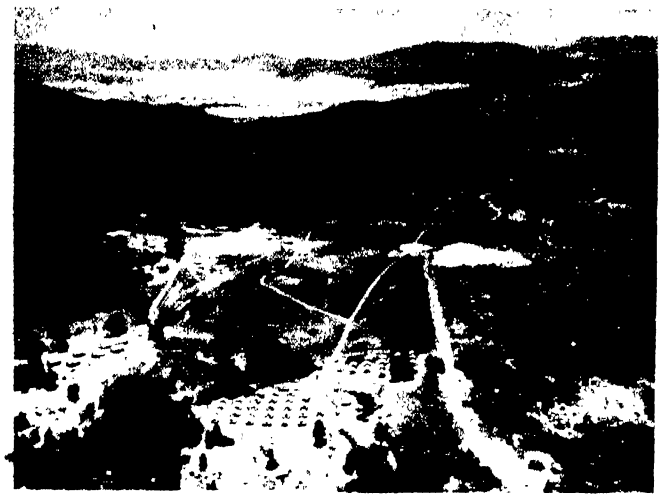


HOW THE BIG 200-INCH TELESCOPE WILL LOOK

BEFORE building the 200-inch telescope a "tenth scale model" has been constructed, and even this is a fairly large telescope—compare with the stair-railing in the background. But the toy car in the lower corner gives the scale of the future 200-inch telescope. The part designated in the article as the "yoke" is the large, U-shaped, sloping piece, and it rotates on its axis to counteract the earth's rotation. On the inner faces of the yoke are bearings on which the big tube (55 feet long in the 200-inch telescope) dips in declination. The pipes are for pumped oil. On the large telescope these will, of course, be hidden.



Scenery surrounding Mt. Palomar, where the great new observatory is being built. View looking in a southerly direction, showing the road which is being constructed up to the plateau—which is at 6125 feet above sea level



Looking in a northerly direction from the observatory site, which shows in the foreground. The dome for the 200-inch telescope will be in the small light-colored patch toward the right. Road makers' camp in foreground

As the 200-Inch Telescope Develops

Promise of an Instrument Better than the Dreams of the Astronomers . . . Construction Under Way . . . To be Finished in Four Years . . . 1,000,000 Pounds

By C. S. McDOWELL, Captain, U. S. Navy

Drawings by Russell W. Porter

As one stands today at the observatory site on Palomar Mountain there unrolls a vast, rugged, beautiful country—lesser peaks blanketed with tall, stately pines and oaks, gorges sharply threading their way between precipitous hills. On the gently rolling summit of this mountain, men are at work pouring concrete for the piers of the 135-foot diameter dome building and for the sub-base of the 200-inch telescope.

The readers of Scientific American have already had the general story of the 200-inch telescope in Dr. Hale's article in the May 1936 number. That article gave a history of the conception of this project and indicated some of the problems which had to be solved in bringing the new telescope to completion. We, who are working on this project, hope to make this telescope a true monument to the vision of Dr. George Ellery Hale, and the generosity of the Rockefeller Foundation. In his article, Dr. Hale states, "How to design an observatory, whether large or small, is a many-sided problem" and possibly I was chosen as Supervising Engineer on this project because the Observatory Council had an idea that Naval Officers are trained and experienced to handle, during the period of their careers, many varied and unique problems.*

We have been fortunate in receiving whole-hearted cooperation from a vast number of engineers and scientists scattered throughout the nation. This cooperation reminds me of that which was obtained during 1917-1918 on many war problems. Such assistance is very necessary in order that we may make the telescope and the observatory the best that science and engineering of today can produce. Taking the astronomical specifications which represent what the astronomers would like to have, and applying what has been developed in kindred fields, we find that we have promise of an instrument even better than the astronomers' fondest dreams. It is hoped that, 50 years hence, this instrument will still be considered modern, and that it will, to a certain extent, be an achievement of which all scientists and engineers of this decade, 1930-1940, may well be proud.

When the 200-inch telescope is finally completed and it begins its task of exploration, it will doubtless reveal new facts about which, at present, we have no clue. Beside these unknowns, however, at least three branches of astronomy will have immediately available new knowledge about the universe in which we live. First, the astronomical horizon will be pushed out. The volume of space whose contents can be studied will be approximately eight times larger than at present. Second, due to the great light-gathering power of this instrument, it will be possible to make large-scale spectra of the brighter stars and increase our knowledge of their atmospheres. Third, much new material will become available about our neighbors in our own solar system, namely, the planets and asteroids.

One of the first undertakings, after obtaining necessary funds for this project,

*The author has specialized in naval engineering and research problems, including the control of naval guns, and was "lent" by the United States Navy for this project.—*Editor.*

The observatory site, looking about north-east. In the foreground are holes for footings for the steel columns for the dome. In the middle is a potential landing field (see front cover). Center background: power house and water tanks. Water is pumped from the canyon beyond, 500 feet lower. Right background: Officials' residences (near trees) and temporary workmen's camps

was the investigation of various locations to determine the site for the new observatory. About five years were spent in the study of possible sites throughout southern California and Arizona, with parties under the direction of Dr. J. A. Anderson, in the field, taking data to determine the average "seeing" obtained at different places, as well as tabulating meteorological data. "Seeing" to an astronomer is a most important factor. If the "seeing" is good, the image of a star is of small diameter and free from local movement, but if there is turbulence in the upper air, the "seeing" becomes bad and the image may become so large and so variable in its position that no satisfactory observation can be made.

Other factors entered into the selection of a site, such as availability of water for the construction purposes and also for use at the observatory when complete and in operation, and it was necessary to have a site which could be reached by a road constructed with easy grades and large radius curves to permit the transportation of the tube and mounting and the various other heavy parts which would be needed for the dome itself.

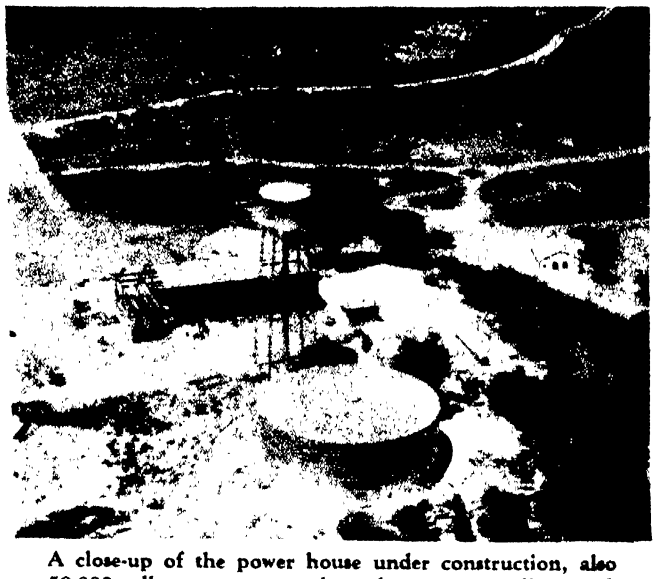
In order to have a suitable location which would be satisfactory now, as well as in the future, the site had to be remote from any probable development of urban population, and free from sky lights from such settlements.

All locations studied were eliminated with the exception of three or four, among which was a site on Palomar Mountain in San Diego County, situated about 90 miles from Pasadena by air line, and about 45 miles from San Diego by air line. This general location was studied by Prof. Hussey some 30 years ago, and covered in his survey report to the Carnegie Institution on "seeing" conditions in various localities. This report was the basis for locating the Mount Wilson Observatory. Prof. Hussey was apparently very favorably impressed with Palomar Mountain but he considered that it was too isolated to be satisfactory for use at that time.

PALOMAR MOUNTAIN was finally chosen after the County of San Diego had volunteered to construct a new and satisfactory high gear road to the site, and it was found that satisfactory arrangements could be made to obtain necessary land. The air photographs, several of which are shown, give a rather good picture of the site as it is today, with construction of some of the buildings for the observatory under way.

The essential mechanical parts of every telescope are the tube carrying the entire optical system, the declination axis carrying the tube, and the mounting supporting the tube, by means of this axis.

The 200-inch telescope is of the commonly employed equatorial type. This type of telescope permits observing at virtually any point of the heavens, by rotating the tube of the telescope about two axes: rotation of the mounting carrying the tube about the polar axis from east to west, called the right ascension, and the rotation of the tube on its decli-



A close-up of the power house under construction, also 50,000-gallon pressure tank and 1,000,000-gallon tank

A close-up view of the beginning construction on the foundation for the great observatory dome: the footings

North end of the "tenth scale" model of the 200-inch telescope. Diameter of tube showing within the split ring bearing, 4.6 feet; but the 200-inch telescope will be 1000 times as bulky as the model. Note pier, two oil pads, and the horse-shoe which affords a broad bearing for the heavy instrument

nation axis from north to south. After the setting on the star is completed, the instrument follows the star; that is, it continues to rotate in right ascension about its polar axis, being driven by a sidereal clock.

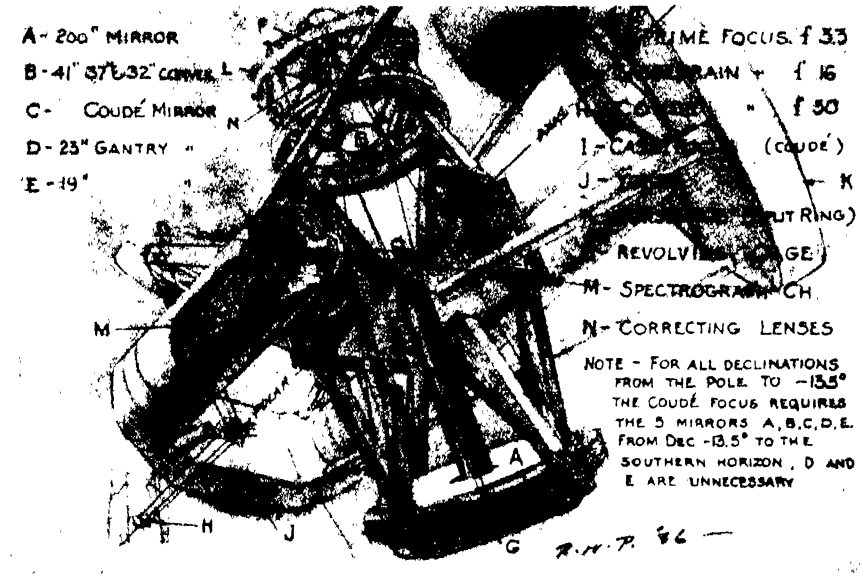
The mounting, or yoke, of the 200-inch telescope represents its polar axis. It is supported on bearings placed on two piers and points north and south at an angle of 33° 21′ with the horizon. This angle corresponds to the latitude of Palomar Mountain, and the polar axis is, therefore, parallel to the axis of rotation of the earth.

The yoke consists of two 10-foot 6-inch diameter tubular girders, spaced at 35-foot center distance, tied together at the south end by a crossbeam carrying the south bearing, and at the north end by a very stiff girder four feet wide, shaped as a horseshoe in order to permit the tube to be pointed as low as the North Pole of the heavens. The overall length of the yoke is 60 feet 6 inches and its total weight is approximately 600,000 pounds.

The entire yoke is built of welded steel sections, in order to permit shipping and handling during assembly. Individual sections of the yoke, the heaviest being about 60 tons, are bolted together. After welding, the sections will be thoroughly annealed in specially built annealing ovens, in order to relieve the internal stresses which otherwise may have caused undue distortion of the structure. The major problem arising in the manufacture of the yoke is the machining of the 46-foot diameter outside periphery of the horseshoe. This surface acts as a journal of the oil pad bearings at the north end, and it has to be machined slightly egg-shaped in order to compensate for the calculated deflection of the structure in its different angular positions.

One of the accompanying sketches, in Russell Porter's inimitable style, shows the tube and optics of the 200-inch telescope and how the mirrors operate in various combinations. The mounting is shown as viewed from the northeast, with parts of the yoke and tube cut away to better indicate the light paths. Salient features are lettered and described.

Let me first call attention to the rather

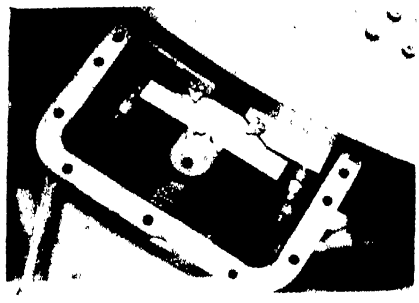


A cut-away drawing made by Russell W. Porter, showing how the different auxiliary mirrors are used in various combinations explained in the text. How big this telescope will be is shown by the yoke at left—over ten feet internal diameter; there is room for the astronomers *inside* the telescope

Changing observers at the prime focus. Access to the prime focus unit chamber, where the astronomer will sit guiding the photographic plate, is by the platform which rides aloft on the shutter arches of the huge 135-foot dome

unusual design of the tube. It is of welded construction, structural shapes being utilized to great advantage. The overall dimensions of the tube are 55 feet 4 inches long by 20 feet 3 inches wide. The approximate weight of the complete tube assembly is 250,000 pounds. Instead of the conventional octagonal lattice construction, the tube starts out with a hollow cube at its center, which carries the declination trunnions. The eight corners of the cube are tied in by beams to eight points on the circular rings at the ends of the tube, four at the upper ring carrying the revolving cage, and four at the lower which support the mirror cell. Tests of a tenth scale model indicate greater rigidity than required by the specifications demanded by the astronomers.

Above the 200-inch mirror, in the lower portion of the tube, are mounted the shutter and iris diaphragm mechanisms. In the center of the cage, and attached



A close-up of one of the two oil pads shown at the top of the preceding page. Oil under pressure is pumped through each of these

to it by means of four edgewise diaphragm plates, is located the 6-foot diameter prime focus unit chamber in which are housed the Cassegrain mirror, two Coudé mirrors and the Ross corrector lenses. Only one or none at all of these mirrors is used when different positions for observing are used. An elaborate but very compact mechanism is, therefore, provided for removing or placing each mirror in required position.

NO Newtonian diagonal is shown. It is intended to do away with this reflection and to use the prime focus directly from the big mirror. In this way considerable saving in light is effected, and freedom from the distortions liable to occur in a diagonal mirror is gained. Above the prime focus unit is located an observer's house permitting observations and photographic work to be performed at the prime focus. A special elevator platform mounted on the dome, permits access to the prime focus regardless of the position of the tube.

The Cassegrain focus is used either below the 200-inch mirror, or by using mirror *C*, it may be deflected through the hollow declination bearings to small spectrographs, housed in the lower chambers of the yoke cylinders.

For the Coudé combination, another convex mirror replaces *B*, and with the aid of *C* the light is carried to a slit in a constant temperature room below and south of the southern pier. Whether it travels by way of *D* and *E*, or directly down the polar axis (depending on the star's declination), it passes through a slot running lengthwise along the south side of the tube; so that this focus, which is *f*/30, requires three or five mirrors. When *D* is not in use, the gantry supporting it, mounted on the yoke and shaped much like a horseshoe, is swung down out of the way.

It is interesting to note that all these mirrors, other than the 200-inch, and six in number, are permanently attached to the mounting, and by electrical control may be made to swing in or out of place as desired.

At last, astronomers will "ride the tube." It is a new problem, heretofore impossible. They must be comfortable over long periods of time, in chairs, or on platforms that remain horizontal while the tube turns in hour angle. An astronomer must be provided with ready access and exit, and while observing, have a sense of absolute security and control over the entire mechanism.

The declination axis of the telescope is formed by two trunnions mounted on ball bearings in the 10-foot 6-inch diameter tubular yoke girders and connected to the tube by means of flexible spoke gimbals. Flexibility of connection between the yoke and the tube is required in order to avoid imposing strains on the tube due to slight inaccuracies in mounting that may occur during assembly and due to deflections of parts.

Changing observers at the Cassegrain focus (near the bottom of the great tube instead of at the top, as shown on preceding page). The observer is raised 35 feet in a bucket, by means of a motor

The gimbals on either side of the tube consist of two alloy steel flanges, one attached to the declination axis trunnion and the other to the tube, joined by 144 three-fourths inch diameter spokes. These spokes are arranged so that their extensions intersect in one point on the declination axis, thus forming a fulcrum. The gimbal spokes permit slight rotation of the tube about these fulcrums, at the same time restraining it against any other motions. There are six additional spokes connecting the gimbal flanges, arranged in a plane perpendicular to the declination axis, to resist the torque required to drive the tube in declination.

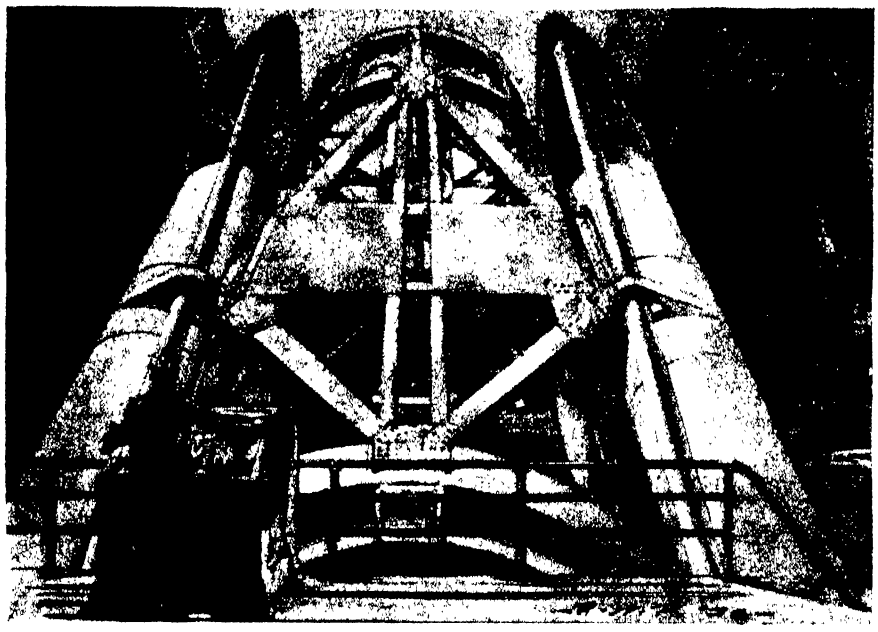
The enormous weight of the entire telescope, nearly 1,000,000 pounds, is carried by the north and south bearings of the polar axis. These oil bearings are of an unusual forced feed type.

At the north end, the horseshoe is supported on two equalized pairs of oil pads spaced at an angle of 60°. The oil pads, 28 inches square, are babbitted and machined to the radius of the outside periphery of the horseshoe. When continuous flow of oil under high pressure is delivered through orifices to the surface of the pads, an oil film is formed between the pads and the horseshoe, thus floating the heavy load.

THE same principle is employed for the south end bearing, which is shaped like a spherical cup. Being a part of a 75-inch diameter sphere, this bearing is capable of carrying both the radial and the thrust loads of the polar axis. Careful distribution of orifices and recesses on the surface of the stationary part of the bearing are, however, required in order to carry the load properly and establish an oil film of uniform thickness along the entire surface of the bearing.

Since the normal rate of rotation of the telescope is very slow —one revolution per day—forcing the oil through the bearings obeys the laws of viscous flow, resulting in bearings which have a very low coefficient of friction. Consequently, less power will be required to drive the telescope in right ascension when equipped with the oil pad bearing, than if so-called anti-friction ball or roller type bearings were em-

A small wooden model of the great telescope and section of the dome

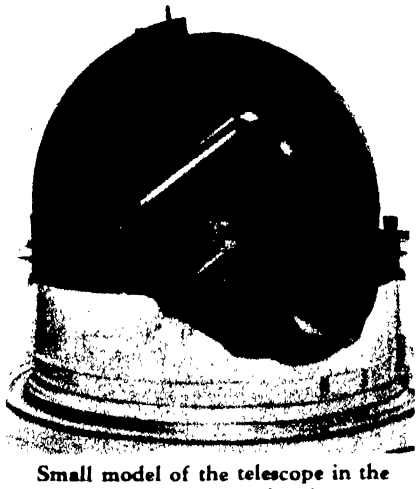


Looking north from the control board—motor nerve center—of the telescope. The tube is shown nested in the split ring north bearing, pointing due north

ployed; oil pads give smoother motion.

The drive of the telescope in right ascension and declination will be accomplished through extremely accurately cut worm gears and worms, driven by synchronous motors operating on alternating current of controlled frequency.

The declination gears will be mounted directly on the tube and the right ascension gears at the south end of the telescope. Setting speeds of the telescope or



Small model of the telescope in the dome, which will be 135 feet diameter

variable rate of motion required, for instance, during observation of planets, will be obtained by means of additional differential gearing.

The telescope will be housed in a dome (see the front cover) 135 feet in diameter and about this same distance from the ground to its top. The lower part of the dome will be stationary, with concrete exterior walls 30 feet high.

Dark rooms, instrument rooms, library, and rest rooms, will be on the ground floor. We are not forgetting a night lunch room, for an astronomer, bundled up like an arctic explorer, needs something hot after hours of stationary observing in the cold mountain air.

The upper part of the dome rotates on smoothly ground rails. This rotating dome will be of steel, hemispherical in shape, with an open slot 30 feet wide through which the telescope points. When the telescope is not in use this slot is closed by sliding shutters. The steel sub-base for the telescope mounting is supported on separate concrete piers, isolated from the dome foundations, so that vibrations from the dome will not reach the instrument. The observing floor is 29 feet from the ground floor. This is in reality an operating and handling floor from which the observer departs, by various contraptions, to one of the several observing stations. He must be raised to the observing house in the top of the tube at the prime focus, or hoisted to the observing platform swung below the mirror at the Cassegrain focus, or he may climb into one of the side cylinders, or descend to the Coudé room. The heights involved are rather unusual, the declination axis on which the tube swings being 65 feet above the ground floor.

THE story of the 200-inch mirror for the telescope is no longer news, its design, construction, and shipment having been thoroughly covered and reported. It seemed as if the whole nation waited with bated breath to see whether it would hit a rock or be too big to go through a tunnel on its trip from Corning, New York, to the Optical Shop of the California Institute of Technology in Pasadena. It was well and carefully handled and now reposes on the table of the large grinding machine. It is hoped that it, with the attendant auxiliary mirrors, will be correctly ground and polished within a period of four years. About four tons of glass must be ground off the big disk, a tedious but not difficult process, in itself. However, it will take infinite patience and care to shape it truly and exactly within the limits of one one-millionth of an inch over the entire surface.

Investigations and researches are continuing on various details of the telescope tube and mounting, on the dome, and on the control and drive of the telescope. However, they are all well along, as some of the illustrations of models will indicate. We have every reason to believe that the telescope and the remainder of this project will be completed and ready for the mirror when the opticians working on the mirror finally say "finished."

Dome for the (relatively) small 18-inch Schmidt telescope camera, which is being constructed at about 1000 feet distance from the main observatory dome

INVISIBLE LENSES

Contact Eye Lenses . . . No Longer A Scientific Curiosity, But Improved During the Past Two Years . . . Now Being Worn For Longer Periods

By THEODORE E. OBRIG
Author of "Modern Ophthalmic Lenses and Optical Glass"

Though very thin, the danger of breakage on the eye is almost non-existent

WITH the recent announcement that over 3000 people in this country alone are already wearing contact lenses* regularly, the invisible, tiny, saucer-shaped lenses, shaped to fit the eye and worn under the eyelids, have now changed from a scientific curiosity to the eye physician's new substitute for spectacles.

Although the principle of contact lenses has been known for over 100 years, during the past two years improvements in the delicate manufacturing processes under which these lenses are ground have been perfected. They are now being worn for long periods by persons who have the usual visual defects of shortsightedness, farsightedness, and astigmatism.

The chief improvement of the past few years that has caused the growth in popularity is a refinement in the method of grinding the inner surface of the little shell so that it presents a continuous gradual curve where it is in contact with the eyeball, which has made for greater comfort. In addition, refinements have made it possible to grind the lenses to within limits of 0.05 millimeter, an accuracy hitherto considered impossible in this type of work.

By another recent development, where especially high corrections are needed in cases of bad eyesight, the added corrections may be ground into the lens itself.

These important refinements have made the use of contact lenses more general in the past few years. However, they were originally developed over a century ago by J. F. Herschel.

Inserting the contact lens with a simple pick-up sucker of rubber

Later researchers, realizing that practically all astigmatic errors in sight are caused by slight irregularities in the shape of the cornea, began to apply contact lenses to correct this condition. Where the cornea is irregular, the contact lens, filled with saline solution to form a homogeneous connection between glass and eye, establishes a perfect sphere. The center section and the solution together, refracting the light rays as would the normal cornea, give normal vision.

In line with these developments, about a dozen years ago Carl Zeiss of Jena began the work of refining the process of making these lenses so that they could be used for ordinary eye defects. In the past few years this has been accomplished, eliminating eye irritation and making it possible to wear them over a much longer period of time than was previously considered practical.

Contact lenses take more time to fit than ordinary spectacles, requiring as many as half a dozen visits to the oculist. With the aid of a trial set of lenses, the oculist determines the correct curvature to insure snug fitting and comfort by actually trying the lenses in the patient's eye, as well as determining the correction of vision by the optically effective part. Permanent contact lenses are then made according to the prescription.

While they are being worn, they are to all intents and purposes invisible. Moreover, since they lie in a protected position under the lids, they are to all intents and purposes unbreakable. (In fact, in one automobile accident where a man's face was badly torn by a corner post of the car, the contact glasses saved his eye.) They may be worn in many places where spectacles would be out of the question—in sports like swimming, skiing, polo and other games.

They provide a double, added safety feature for automobile drivers in that they neither steam nor have the disturbing and sometimes dangerous reflections that spectacle lenses have.

So small and thin are the lenses that they are invisible when worn

*See also page 191, March 1931, Scientific American.—*Editor.*

OUR POINT OF VIEW

8113 A.D.

IF ancient man had only had the foresight—and the wherewithal—to preserve an accurate record of his life and times, what a vast expansion of our cultural knowledge would be available to us today! Since such was not possible, we must dig through antiquity's leavings for our knowledge of the past; dig, sort, theorize, always revising our knowledge as new finds come to light. Just because we are not favored in this respect is no reason why we, with our technical abilities, should not do the right thing for future civilizations.

On the two following pages Dr. Thornwell Jacobs, President of Oglethorpe University, Georgia, outlines a plan which, if carried to completion, will give to the world of 8113 A.D. a complete and thorough knowledge of the manners and customs, the pleasures and industries, of our part of the 20th Century. Here is a proposal that is at once inspiring and practical, thought-provoking and philanthropic. It is entirely possible to project ourselves, as it were, into a civilization as yet undreamed of, to bring to bear on future minds the influence of our knowledge and progress. Scientific American wholeheartedly endorses Dr. Jacobs' suggestions. Will you co-operate toward their fulfillment?

Munitions

NO one wants war. At least no one in the United States does. Certainly our military forces have no jingoistic ideas; and our "big bad wolf" munitions makers have other and very much more profitable products to make. We are simply not an aggressor nation.

There are some Americans, however, who rant, write letters to the papers, petition Congress, and demand investigations (and sometimes get them) when they hear of the development of a new rifle, a new tank, a new explosive. "Nationalize Munitions," they demand, and the multitude, knowing not the facts, takes up the cry and yowls to high heaven regardless of sense or logic. Perhaps some "munition makers" have erred in exporting supplies for warfare, but present neutrality legislation has curbed this practice and further amendments to the law may effectively stop it. There still should be private manufacture of munitions.

Major-General William H. Tschappat, Chief of Ordnance of the United States Army, writing in *Army Ordnance*, says in no uncertain terms that such production must continue. He feels as do many other sensible Americans that, while we must do all in our power to avert war, we must keep our eyes wide open and be prepared for the possible thing which could force us into a contest of arms. "The War Department is convinced," he says, "that in the event of war, American industry must produce the major portion of the required munitions. Assuming this premise, it follows that so far as practicable industry should be prepared to perform its war mission. Therefore the War Department has consistently favored the participation of American industry in munitions manufacture and has encouraged the production of munitions . . ." The manufacturing arsenals of the Army in time of peace assist in the development of new designs and improvement of existing material, keep alive the art of manufacture of ordnance; that is practically their sole function.

We applaud General Tschappat's statement, which apparently is official. It clears the air a bit and is, in our opinion, a sound stand. The small government arsenals could do little in time of war; yet to maintain, at government expense, a great peacetime manufacturing establishment against the possibility of war would constitute an unconscionable drain on the already overburdened taxpayer. On the other hand if we do want to nationalize munitions and *do not* maintain that large peacetime establishment—well, how many hundreds of thousands more white crosses would we have left in France had our government had to start from scratch in 1917!

Cotton

SPINDLES of metal—over a thousand of them, wet, probing through leaves and stalks—will take the place of nimble fingers to pluck the ripened fiber of southern cotton fields if a machine, recently demonstrated in Mississippi, fulfills the predictions of those who inspected it. As yet it is far from perfect. A ponderous machine, it is said to have picked in a day as much cotton as 70 or 80 men and women could have picked by hand. However, its picking spindles, while they did not harm the plant and unopened bolls, did pick up a green stain, some opened but unripe fibers, and bits of leaves and trash—all of which reduced the market value of the cotton.

The editors have watched the development of this machine of the Rust brothers for some years but, despite many promptings from readers, could not discuss it in its incomplete state. Now, because of the furore of prediction accompanying its demonstration, an evaluation of its possibilities is in order.

In its present state, the Rust machine will do a job much more cheaply than before but will turn out an inferior product. Even so, the economic advantage is there, and newspaper headlines would lead the hasty reader to believe that an economic revolution is in prospect immediately. This is erroneous, for the Rust cotton picker functions only on flat lands, is not suitable for the rolling, hilly country in several of the cotton states. Then, too, it is believed that the machine may prove too expensive for the small cotton grower. These limitations may later be removed, but in the meantime they may, slowly, teach the small farmer that he has been too long a slave to a "starvation crop." Cotton prices forced down by the big planters using the new machine may serve to do what the boll weevil did to farmers in the peanut belt of Alabama years ago—drive many cotton farmers to more profitable, land-saving crops.

The Rust machine will no doubt be improved. Even as it stands, it will, if enough of them are built and used, change the traditional economics of a vast section of the country. Perhaps its most important effect would be the ending of the poor southern farmer's slavery to cotton, as indicated above. It would deprive some few millions of people of their picking jobs, and many of these will migrate to industrial centers, but not 7,000,000 of the 9,000,000 tenant farmers will migrate, as the editor of one of our illustrious dailies predicts editorially. Young cotton must be "chopped" (thinned out) in the spring by hand, and this requires large numbers of workers on short notice for a very limited time. How that same editor figured that the Rust machine would also displace most of the 5,000,000 southern mules and horses is difficult to understand. Animals are not used at cotton picking time except to haul the loaded wagons and that job is but a minute part of the regular work they do.

The new machine *is* important. It will be more so with each and every improvement. Law makers who already are talking of laws to prohibit its use are shortsighted and lacking memory of the economic importance of other labor-saving inventions. They may as well proscribe the cotton gin—these modern King Canutes who like not the wash of progress upon their political thrones.

TODAY—TOMORROW

Archeology In A. D. 8113 . . . An Opportunity For This Generation . . . Preserving Records For Posterity . . . Co-operation Needed

By DR. THORNWELL JACOBS
President, Oglethorpe University

THE time is A.D. 8113. The air channels of the radio-newspaper and world television broadcasting system have been cleared for an important announcement. Suddenly all is activity again. The radio-newspaper headlines blaze forth a story of international importance and significance. The television sight-and-sound receivers in every home throughout the world carry the thread of the story. In the Appalachian Mountains near the eastern coast of the North American continent is a crypt that has been sealed since the year A.D. 1936. Carefully its contents have been guarded since that date, and today is the day of the opening. Prominent men from all over the world assemble at the site to witness the breaking of the seal that will disclose to a waiting world the civilization of an ancient and almost forgotten people. When the crypt is opened, there is revealed a mine of information regarding the science and civilization of A.D. 1936, conveyed by means of what those ancient people called phonographs and motion picture machines, models and books and photographs showing how far their civilization had progressed.

Thus projected into the future is a glimpse of what can be—what probably will be—if we of this generation seize the opportunity to preserve for the future a complete record of how we live, and to give to the generations of thousands of years hence a carefully thought out record of what we have accomplished up to the year 1936.

WITH the thought in mind that this is the appropriate time to preserve such records for future generations, on a scale never before conceived, Oglethorpe University in co-operation with Scientific American proposes to make available to some civilization now unthought of, and still far in the future, the running story of the life, manners, and customs of the present civilization. We propose to collect a complete set of materials which describe and represent our lives and labors, to bury these materials in a secure spot, and to preserve them under the guidance and advice of our greatest scientists. We believe that in this way generations as remote from us in the future as ours is from ancient Menes and the pyramid builders will be able to visualize what manner of men we were and what manner of life we lived in 1936 A.D.

THE suggestions of Dr. Jacobs for the preservation of a record of our present generation for the assistance of future historians are heartily endorsed by Scientific American. If it is possible to secure the co-operation of industrialists and philanthropists, this project can undoubtedly be carried to a successful conclusion. All those who are willing to assist in this monumental work are urged to communicate directly with The Editor, Scientific American, 24 West 40th Street, New York City.

It may be difficult for most of us to realize that our present civilization and all of its technical advances occupy only a few seconds, as it were, in the vast spread of geological time. We are living in a geological epoch just as truly as did the brontosaurus and the pterodactyl. Time will last just as long in the future as it has lasted in the past; our present-day civilization will eventually fall; our tall buildings and huge dams of which we are so proud will be reduced to ruins. This may not be a pretty picture to contemplate but it is one that will be just as true as the story of the downfall of the mighty empire of ancient Nineveh.

We may be able to appreciate this more fully when we consider the rapidity with which the records of any particular generation disintegrate and lose themselves as the years go by. Even knowledge of the life of the Middle Ages is already dimmed by time. Its reconstruction by present-day students is largely guesswork. Had it not been for such a natural catastrophe as the eruption of Vesuvius, the glories of Pompeii and Herculaneum would never have been revealed to our sight. Again, if it had not been for the happy circumstance that the world's oldest civilization was developed in Egypt, where excessive dryness made it possible for the structures to be preserved by nature, we would know very little of those times. We, however, are the first generation equipped to perform our archeological duty to the future without the help of natural phenomena.

In order to make more positive that any "treasure" which we may bury would be held safe from vandalism and pillaging, it is desirable that a date be fixed for the opening of the crypt. What could be more fitting than that the time be governed by the first fixed date in history? This is probably the year 4241 B.C., which marks the establishment of the Egyptian calendar. Since that first date 6177 years have passed. Adding this figure to 1936 brings us to A.D. 8113. The probability is that by that year the record of the present generation of citizens of the United States of America—except for that sealed in our crypt—will have been as completely destroyed as the record of the contemporaries of Menes.

WHAT we propose to do, then, is to provide for future historians an epitome of the life of an old generation—a generation in which *we* lived. Thus, for the first time in the history of a civilized land, future historians will have available a thorough and accurate record preserved for them. Such an epitome should include certain books—for example, encyclopedias—stored in the sealed crypt. Motion picture films would, of course, be included, picturing the world of today, and especially the physical features of our cities and countrysides, our industries and our social activities. There should be a phonograph or film record carrying a salutation from the President of the United States to the rulers, whoever and whatever they may be, of the year 8113 A.D. By means of the phonograph and the talking motion picture film, this future generation will be able to hear the voices of our President and King Edward VIII, of Mussolini, Stalin, and Hitler, of the Emperor of Japan and the President of China, as well as those of our greatest living scientists, archeologists, and historians.

The subject of this proposal has been completely discussed with the editors of Scientific American, and they have indicated their willingness to co-operate in its fulfillment. Our conversations have covered the entire range of human activity. We must, of course, include such homely every-day things as the foods we eat, our drinks, even our chewing gum. We must describe and illustrate our sports and recreations, our buildings and their furniture, our engines, printing presses, automobiles, airplanes, typewriters, and so on. Models made of stain-

less steel or Monel metal, when preserved in a vault lined with similar materials, will no doubt last for at least 6000 years. Of course an illustrated encyclopedia, if it could be printed with an ink that did not carry self-destruction in its formula, and on a paper of the most permanent possible quality, and preserved in a vacuum or in inert gases, would be one of the most perfect ways to preserve permanently a description of the thought and content of our present civilization.

Perhaps one of our great metropolitan dailies would be willing to print a special issue with an ink and paper of the type mentioned above, showing the treatment of our "news" and possibly containing a message addressed to those living in 8113 A.D. Thus we can convey an idea of our news disseminating system and of our methods of advertising. Such a newspaper might be encased in a stainless steel receptacle filled with inert gases. On the other hand, several different newspaper editions might be photographed in miniature on motion picture film and included in the crypt, together with a projection machine and instructions for its operation.

The beautiful fireproof building at Oglethorpe, under which it is planned to store a complete record of our present civilization for future historians

IT is firmly believed that industrialists of this country can plainly see the tremendous cultural value of this proposal and that they will co-operate to the fullest possible extent. Doubtless one or more of our great automobile concerns would be willing to make miniature models of its finest products. Motion picture organizations could probably be induced to make a study of the very best possible way in which to preserve films for a period of 6000 years. Hundreds of our manufacturers would likewise co-operate in their own particular branches of industry. There should also be included a complete model of the capitol of the United States, which, within a half-dozen centuries, will probably have disappeared completely. It gives one something of a shock to reflect that by the year 8113 A.D. every building of every kind as yet constructed in the world may no longer exist. Such a reflection, however, emphasizes strongly the desirability of a project such as the one under discussion.

The principal difficulty, from a practical standpoint, in effecting this plan would not be the scientific one of preserving the objects selected for that purpose. It would be the danger that comes to all civilization sooner or later: vandalism, which involves the destruction of its monuments and the robbery of its vaults. Doubtless the safest place and the one which has the greatest promise of permanency would be a college campus, for universities have a way of living and surviving such things as changes in forms of government and dynasties. Oglethorpe University has selected an ideal spot for this purpose in the basement of a beautiful building which now houses its library and executive offices. The basement has already been rendered waterproof and, when lined with stainless steel, would preserve objects committed to its care over the period of time desired. The size of the crypt is quite sufficient for the purpose. It is contained in a building constructed of granite and covered with slates, with foundations resting on the granite bedrock of the Appalachian Mountains. This location is ideal for such a project, the bed rock being of very ancient geological formation which beyond doubt will withstand the ravages of time with little change. Further, as far as science can determine, there is little likelihood of earthquakes that might destroy the building or the crypt. Such a building should itself endure for the period of time desired, if properly repaired. There should, of course, be a tablet of stainless steel, requesting all future generations to leave its contents unopened until A.D. 8113. The vault and its contents should be deeded in trust to the Federal government, its heirs, assigns, and successors, and a penalty fixed by law for any tampering. A special feature of the plan would be the preservation of the names of all those persons who took part in the task. The expense of such a project would be considerable but surely there are enough philanthropists in America to make it possible. Nothing has ever been proposed which combines so much romance and usefulness and real service to future students of civilization as this.

The problem of preserving the various materials used in this project will require careful study and the complete co-operation of all of those interested. A carefully selected Board of Judges will be charged with the responsibility of drawing up a list of those things which should be preserved, and of deciding which can best be preserved by written description and photographs and which should be in model form. It will then be up to those who are far-sighted enough to see the implications of this project to begin the preparation of materials to be included and to start work on the crypt and its surroundings.

There is little definite data available upon which to base this interesting task. Similar suggestions have been made in the past, but none of them as broad in scope as the present. We may take a hint from the work of the Japanese who, shortly after the tragic earthquake of 1923, determined to preserve for 10,000 years the names of all those who perished in the disaster. After a vast amount of investigation they decided to write in Chinese ink upon the highest quality of Japanese paper the names of those who were lost. Some 548 sheets of paper were used. These were put away in four jars of fused quartz crystal, each five inches in diameter and twelve inches long. The bottles were then wrapped in asbestos and placed in a lead container which, in turn, was put into a fireproof cylinder of Carborundum. A Buddhist temple was finally chosen as the proper repository for the precious bottles.

SCIENTIFIC AMERICAN has consented to act as a clearing house for suggestions and offers of co-operation in our project. With the tentative plan outlined above as a starting point, we solicit suggestions and advice from scientists, publicists, and philanthropists. As the project proceeds, the plans will undoubtedly be modified in accordance with changing ideas.

During the last one hundred years, scientists, backed by philanthropists, have spent millions of dollars, digging here and there in the earth, endeavoring to find some old piece of pottery, some ancient trinket, some sun-baked brick, from which they might deduce the every-day manner of living of people whose names are forgotten, and of kingdoms long since perished. The record of each generation is full of interest and wisdom. Let us be the first generation to preserve, for the intellectual hunger of those who come after us, a complete record of our daily life.

A typical paper plant with an abundance of water and complete shipping facilities

PAPER PROGRESSES

New Technique in Paper Making . . . Yet Tradition Persists . . . New Papers . . . New Processes . . . The Rôle of the Laboratory . . . Increasing Efficiency

By PHILIP H. SMITH

THE most striking thing about American industry is the new products which have been developed under the spur of the depression, competition, and research. Well, the paper industry is different. You may learn that most ladies' handbags are now being made of paper, that paper is going into table tops and wall panels, and you may conclude that the industry is stepping out to seize all manner of markets; as a matter of fact the significant advances are to be found principally in the technique of manufacture.

It is hard to find an industry in which progress has been made so uniformly on so many fronts. Every unit which contributes to the job of turning the raw material into a finished product has been given attention, and the combined result makes an advance within the industry of great economic importance.

Another fact which sets paper making apart is its great antiquity and the persistence of traditional method. The use of cellulose fibers as a raw material and the practice of sizing and coating are Chinese arts centuries old. They have never been overthrown. The contribution of modern times has been to raise production rates and to lower costs through the application of science and technology.

The center around which paper making spins is the paper making machine. It is a gigantic combination of intricate mechanisms which takes in raw stock at one end and spins forth paper at the other. A full sized machine approaches 200 feet in length, weighs nearly a million pounds and costs in the neighborhood of a half a million dollars. Because it is a grouping of machinery one might say that there is a hazard every foot of the length. There are some 50 individual motors, about 25 pumps, thousands of feet of pipe and many miles of wire. Every unit must co-ordinate perfectly to deliver a product that is satisfactory.

THE raw material goes through an elaborate treatment before reaching this machine. The fibers, obtained chiefly from wood today, have to be thoroughly saturated and macerated or "beaten" in and with water as well as freed from impurities. They must flow onto this machine uniformly as a liquor comprising 99.5 percent water and 0.5 percent solid; then the machine performs the function of removing the water, first by drainage, then by suction and press action, and finally by heating. It reads like a simple process, but it is enormously complex. There are many variables which require control; there are endless points at which troubles may arise; by the same token there are opportunities to exercise scientific control and to perfect the functioning of the mechanism.

The raw materials used are primarily water and cellulose fibers. Good water in unlimited volume is an essential. There was a time when it could be had easily and used without treatment but today most supplies must be carefully purified. A mill may use as many as four or five million gallons a day and, for reasons of economy and avoidance of stream pollution, a beginning has been

TABLE 1
Paper Making Fibers and Some Principal Uses

Wood Fibers
- **Mechanical**
  - Groundwood (spruce)—news, wallpaper, cheap book, and writing paper made in combination with sulfite
- **Chemical**
  - Sulfite (spruce)—bond, ledger, writing, tissue
  - Alpa (refined sulfite)
  - Soda (popular)—book and blotting
  - Sulfate, or kraft (pine)—wrapping, container lining (modified soda)

Seed Fibers
- Cotton (rags and clippings, linters)—writing, legal

Bast Fibers
- Jute, Manila —tag, some container
- Straw (wheat, corn, etc.)—corrugated board
- Esparto—used abroad
- Linen—currency

made in using the water over again by installation of what amounts to a closed system.

There are many ingredients to paper and in Table 1 the fibers are classified with some of their principal uses. Wood sulfite cellulose is made by high pressure and temperature digestion, strong sulfite acid treatment, and purification with chlorine and calcium hypochlorite, followed by a final alkaline digestion and heat drying. The sulfate, or kraft, and soda pulps, are made by high temperature digestion, a concentrated cooking with a caustic alkali, and then a bleaching. The rag fibers are subjected to an alkaline digestion to remove such impurities as waxes and resins and are then bleached. The chemical wood and bast fibers are used both bleached and unbleached. Practically all papers are composed of at least two components.

The highest grade of bond papers are made with rag stock but today sulfite pulp can be used to make a paper equal in quality to one made with low grade rags. The use of alpha, a purified sulfite pulp, is a story in itself. Being highly refined it has special uses, many of which do not involve paper. Rayon is an example.

The raw material content of paper varies according to product. A high grade white paper can be made of sulfite pulp and old paper, provided the latter was made originally from sulfite. The paper these words are printed on, for example, contains some re-worked paper from old periodicals. Before old paper can play its part, however, it must be sorted to eliminate groundwood stock, screened to take out wire and string, and bleached and washed to remove ink.

If you examine a fiberboard container (shipping carton) you will find old paper used in another manner. Under the tough outer surface is a softer product made from mixed papers and if you look closely you can see foreign material scattered through it.

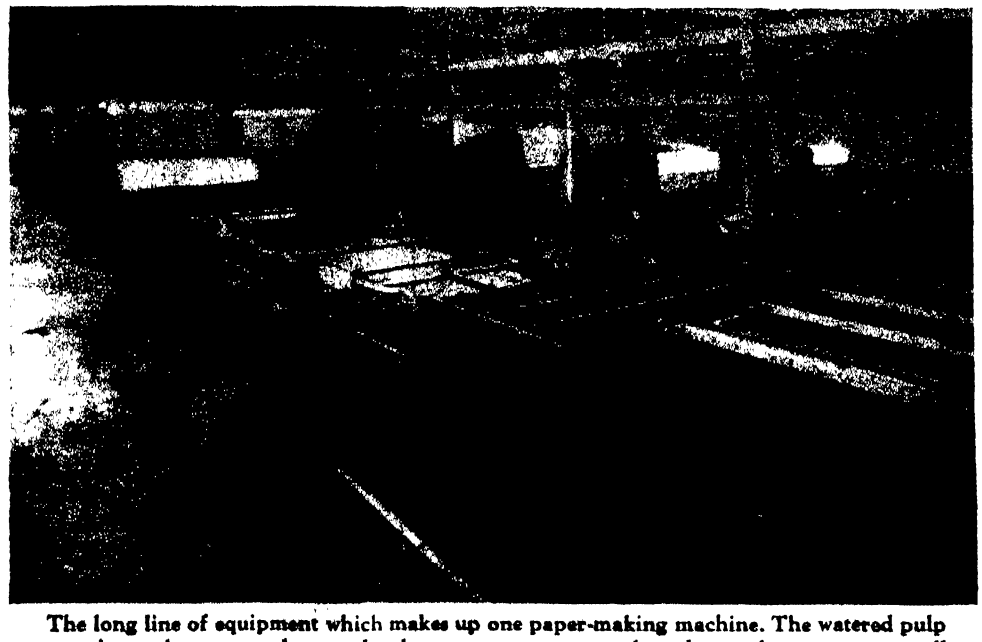
The outstanding advance in pulp has been the development of a new source of raw material. In the past 10 years the rise of kraft paper manufacture in the South has been phenomenal. Output of this tough, brown paper has risen from production of a few thousand tons to hundreds of thousands of tons, and new mills are springing up which will double present output. On top of this comes Dr. Charles H. Herty's development which makes possible the production of white newsprint paper from southern pine.

Dr. Herty's work has been told in these pages before.[1] What he has done in brief is to disprove the idea that southern pine was useless for sulfite paper making because of high resin content. First he found that young pine contains no resin, then he made paper from it. Commercial production is being attempted and watched with a great deal of interest because the proof of feasibility might lead to great development in the South. Proponents declare that such an industry would be self-perpetuating because young forests are used and could be re-planted to serve in a 10-year cycle and because essential raw materials are available. Others hold that, though possible, such a development is not probable. Sulfite pulp, they say, can be produced more economically on the northwest coast where even old wood can be used because it is free of pitch.

THE mixing of pulp with water to provide the vehicle with which to flow the fibers through the machine has always required an undue consumption of power and, therefore, has attracted the attention of research. First there are beaters which grind the pulp with water to hydrate it and then jordans are used to break the fibers down to a more uniform size. Newer methods aim at simplification and lower power consumption with greater control of the process.

From the moment the flowing begins, and the fibers are felted together, effort is made to remove the water with dispatch. And this is true whether the machine is a Fourdrinier or cylinder type. Improvements in the water-removing

[1]Scientific American, May, 1934, Page 234



The long line of equipment which makes up one paper-making machine. The watered pulp goes in at the near end; completed paper comes out at the other end, goes onto a roll

Boring test samples from bales of pulp imported from Finland

mechanisms begin with the Fourdrinier, which is a fine mesh bronze wire screen belt over which the wet material is carried while superfluous water is removed and the felting of the fibers is accomplished, sometimes with the aid of shaking. A new type of Fourdrinier can be slid out of the machine for restringing if a wire breaks, while lengthening of wires to give higher speeds is quite common.

Various devices are used to remove the water—suction boxes under the wire, rolls which apply suction and pressure, and finally heat. The correct degree of pressure is important. The heavier the pressures the quicker the removal, but at the same time excess pressure applied upon the wet web will ruin the formation of the fibers and weaken the sheet; likewise excessive pressure will mark the sheet. Nevertheless, if water is not removed adequately before the sheet leaves the press section and enters the dryers, more drying will be needed and heat is costly.

A RECENT improvement has been to cover the suction press roll with rubber. This permits lower pressures and prolongs the life of the felts which are used to carry the wet web before it can support its own weight in passing from press roll to press roll. Another innovation, the dual press, permits a contraction of the press section so that additional space can be given to forming or drying areas.

The final processing before the paper is wound up on a roll is pressing the web between heated rollers—a calender—and ironing to give it a smooth surface. It is recognized that slow drying makes for high quality, yet speed is demanded to maintain production rate and a compromise is required. A vacuum drying system just developed permits drying with diminished heat. The drying section of the machine is completely housed so that it can be held under 29 inches of mercury and since the paper must enter and leave the housing, it is an accomplishment of no mean proportion.

Hand in hand with the technological improvements which have enabled paper mills to manufacture a product of better quality at higher rates of speed and at lower cost, there has been research activity without which technological improvement would mean little and which has established precision control over operations. This brings uniformity of product and reduction of waste. The laboratory is now the right hand of the progressive mill. Here is where control of the pulps, then blending and processing are determined to give a desired result. Here is where the moisture content is watched as the paper goes through the machine, and where final tests for strength, opacity, surface and so forth are made to maintain uniformity.

Final screening before the wet pulp flows on to the Fourdrinier

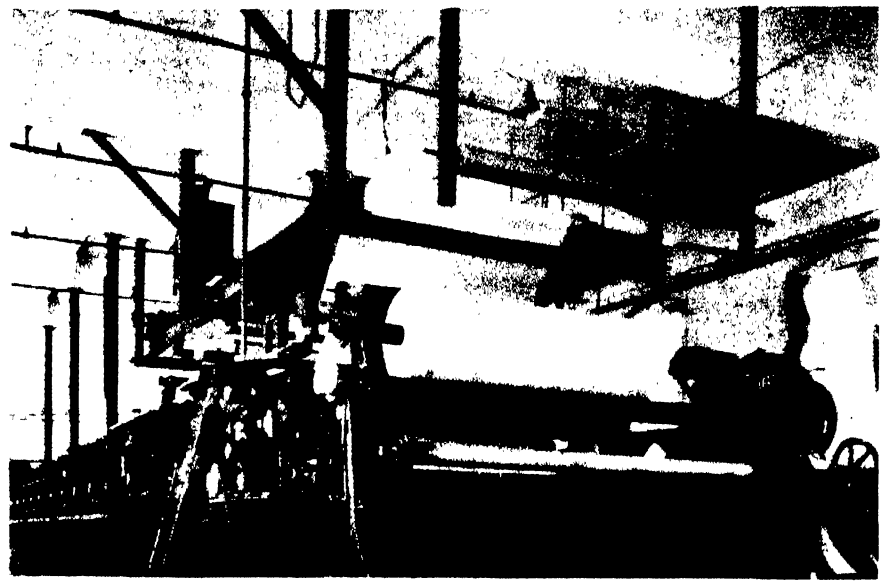
At first sight the rôle of the laboratory seems overplayed, but after you have seen newsprint roll off a machine at the rate of 1400 feet per minute and come to realize what a mass of detail contributes to the achievement, no control can seem too great. Research is in steady demand to meet new problems. Consider, for example, the problem created by the acceleration of printing press operating speeds. Printers called for inks that would dry faster and the ink manufacturers turned to the paper makers for a product that would take the newer inks. Substitution of paperboard for wood in manufacture of shipping containers raised another problem. Paper had to be certain to withstand tearing and bursting and to get satisfactory results meant going all the way back to the pulps.

Research works for economies as well as for better quality and a notable example of this was revealed in a recent announcement that sulfite liquor, by-product of sulfite pulp manufacture, is being used for the making of yeast.[2] Until now it had the negative value of polluting streams. Sugar is a content of sulfite liquor and when treated with lime, yeast can work in it and use up the sugar. In Nova Scotia there is a paper mill with a yeast plant attached which is producing 20,000 pounds of yeast every week, at the rate of 40 pounds to a ton of waste liquor from the processing.

[2]Scientific American, September, 1936, Page 162

Mechanical counting of sheets of toilet paper, perforated and packed on the roll at lower left

In the West, commercial enterprise has approached the problem of waste and stream pollution from another angle. Finding that the liquor contains organic matter from the non-cellulose constituents of wood, which are lignin substances and carbohydrate materials, a precipitation process has been evolved which uses a caustic lime reagent and obtains three things thereby: calcium sulfite, used for the manufacture of fresh cooking acid; a solid from the lignin component which serves as a boiler fuel; and an effluent which is less harmful when emptied into streams. Out of the lignin materials, experimenters have been able to produce vanillin and other phenolic derivatives and to extract a substance for tanning leather. This last product is established commercially. It is now declared that other products can be obtained and that commercialization is not far off. What is now waste and available in ample quantities can thus be turned to value by sustained laboratory effort.



Delicately adjusted steel rollers pass the continuous sheet of paper through many intricate turns to dry and surface it and discharge it at this point ready to use

JUST to get an idea of the tremendous use of paper and the importance of the particular types, figures of last year's output are illuminating. The total production reached 10,307,000 tons. Of this grand total, paperboard represented 4,693,000 tons; newsprint, book, and cover paper 2,153,000 tons; wrapping paper 1,570,000 tons; and writing, tissue, and other papers more than 1,800,000 tons. The use of paper is increasing in two directions: existing use is being extended and new uses are being developed. It is no secret that wooden shipping boxes have lost ground to fiberboard containers ever since the industry succeeded in making a carton sufficiently strong to withstand blows and shocks. Nor is it a secret that containers are striving to annihilate the glass milk bottle. If a satisfactory paper can is developed for the shipment of oils there will be a like onslaught on tin cans. Paper lends itself to a variety of treatments. It can be made impervious or absorbent and the latter type has been making inroads in the towel business much to the discomfiture of those who live by textiles. A simpler use, but still a novel one, which illustrates diversity, has recently been projected for parchment paper. It is brought forward as a substitute for the glass upon which dentists and apothecaries mix amalgams and drugs.

Nowadays paper is being laminated with coats of synthetic resins to make it moisture proof. This is used for sealing containers when a chemically inert material is needed because of the character of the contents. Parchment papers are scarcely affected by water. They are made in the usual manner but treated after manufacture with strong sulfuric acid. Plastic sheets, used for table tops and wall panels, contain paper to give strength. More usually, the paper is alpha cellulose, the highly refined sulfite pulp. Similarly, paper is given waterproof qualities by coating or impregnating with rubber latex and artificial resins. Chemicals which must be kept absolutely dry in storage or shipment are now packed in impregnated bags or bags with liners coated with nitrocellulose or similar cellulose lacquers. Ladies' handbags which look like leather can be made from impregnated paper, coated with lacquer and embossed with a leather grain. They haven't the wearing qualities of good leather but even the cheap ones will last the season or as long as the costume they are intended to match.

Perhaps the most startling developments in paper making have yet to come. Science has only recently begun to play its proper rôle because paper making was too old and too well established an art to yield with grace, but today the industry works singly, and jointly with its Institute of Paper Chemistry. We are seeing now a period of transition when what has been fact for centuries is up for reconsideration, when ground is being retraced to search out facts which escaped the artist-producer. To understand the reasons for physical and chemical phenomena and to establish control for re-creating them at will is the aim of the progressive mill. This is exemplified by the study made of fiber structure and the effect upon it of chemical treatment, the determination of hydration by instruments rather than by reliance upon the finger tips of an individual. Imagine testing the appearance of a sheet of paper by means of sound! It's coming out of the laboratory. Research everywhere in the mills is voiding the old rule-of-thumb to replace it with accurate measurement and positive control.

Manufacturers will admit that the present system of making paper seems antiquated for this age of simple and direct processes. It requires too much machinery, too many processes and too great a capital investment, yet no one has found a better way. Simplification is always sought and a good example has to do with the coating of paper. Coating in the manufacturing process is now an established fact; one step replaces two. Mills are getting into operation with the new process, but as yet details are lacking. Enough is now known of this process as it gets underway to indicate that the seemingly impossible in paper manufacture has been accomplished. Further perfecting should make it applicable to the coating of a wider range of papers.

The basic idea of paper making is the most irritating one of all to those engaged in manufacture. Why, they say, should we go to so much effort to hydrate fibers and then labor even harder to remove the water a few minutes later? It seems inefficient and so it gives rise to a pipe dream—the finding of a cheap and recoverable solvent that will serve as a vehicle for the fibers.

MEANWHILE, lacking a revolutionary change in the fundamentals, the paper industry goes on increasing the efficiency of unit operations. Water filtration costs are being lowered, power consumption is being cut, wastes are being eliminated or put to profitable use. The industry takes on slowly the appearance of a self-contained unit instead of one which passes through its system millions of gallons of water daily, consumes endless power and chews up whole countrysides merely to produce smooth sheets to convey some facts like these.

Photographs courtesy Beloit Iron Works, Byron Weston Paper Mills, Fitchburg Paper Co., Robert Gair Co., and Scott Paper Co

More About the New Lyttleton

The Older Encounter Theory is Fortified . . . Removes the Last of the Dynamical Difficulties . . . But the Whole Problem is Still Far From Solved

THE story was told last month how Lyttleton has advanced one of the perplexing problems of cosmogony by suggesting a way of origin for the planets which avoids the hopeless dynamical difficulties which obsess the older theories. If the sun had originally another star revolving around it—perhaps at about the present distance of Uranus or Neptune—and a third star, passing by in space, collided with the companion, or at least passed exceedingly close to it, it is quite possible that both stars might fly away into space in different directions leaving masses of ejected matter under the control of the sun's gravitation to condense into the planets. Later encounters between the embryo planets might account for the formation of their satellites. The "encounter theory" of the origin of our system has thus been revived and strengthened just as it appeared to be fatally weak.

This should be as gratifying to the Americans who originally proposed the idea as to the Englishmen who have expanded and improved upon it. Before we leave the subject, however, it is only fair to point out that certain serious difficulties still remain which make it far from safe to announce that this great problem has been finally solved.

The great difficulties regarding angular momentum have apparently been finally escaped. The worst one depended on the angular momentum per ton, and demanded that planets moving in their present orbits could never in the past, since they became separate free-moving bodies, have passed nearer the sun than half their present distances, and hence that they were not born from the sun. The new theory, which puts their birthplace far out and deprives the sun of its parental relation, accepts the hostile argument and makes it a part of its own case; but it is not itself altogether free from dynamical objections.

The new-born planets, starting as they must all have done close to the point of collision and moving with very different velocities and periods, must have had highly eccentric orbits—though not so extremely eccentric as on the old theory of origin from the sun itself. How did their orbits become rounded up into their present nearly circular shapes? The explanation which was suggested in the earlier encounter theories is still available. The great cataclysm of the encounter must have caused the ejection of much more matter than eventually consolidated into the planets. Some of this may have cooled and solidified into small solid particles like Chamberlin's planetesimals, but a great deal of it must have been composed of hydrogen and other "permanent" gases if the composition of the stars was in the least like that of the sun or of other stars in general. These gases would fly away, each atom or molecule separately from the scene of the encounter: some molecules would be moving fast enough to escape altogether from the sun's attraction and join the homeless swarms which thinly pervade interstellar space. But great numbers would be going too slowly to escape and these would circulate about the sun in orbits and form a vast diffuse envelope surrounding it, though not a true atmosphere since the orbital motions, rather than the gas-pressure due to molecular collisions, keep it from falling into the sun.

THIS great cloud of gas and dust forms an ideal resisting medium. The relative motions of its separate constituents would soon be equalized by collision, leaving the mass rotating in practically a circular fashion. The heavy planets would plow through this and be subject to friction. Both the outward and inward motions of a planet would be slowed down. The forward motion would be slowed if it was moving faster than the medium, which would happen in the part of its orbit nearest the sun, but speeded up when the gas particles, moving in their circular orbits, overtook the planet, which would occur at or near the latter's aphelion. All four of these influences operate to diminish the eccentricity of the orbit. Given time enough and resisting medium enough, very great changes might be produced. The resisting medium produced by the encounter which Mr. Lyttleton postulates is exactly in the right place to do the most effective work. There is still trouble, for a planet big enough to hold an atmosphere should be "sticky." A gas molecule or meteorite which entered its atmosphere would never get away again but be added to its substance. Now, if the outward and inward motions of such a body are to be slowed down to a small fraction of their original speed, the total quantity of matter picked up from the resisting medium must greatly exceed the original mass of the planet. There is very strong reason to believe that most of the ejected material was hydrogen, which is far more abundant than anything else in the outer layers of the stars. We should then expect all good-sized planets to have extensive hydrogen atmospheres. This fits very well for Jupiter and Saturn, but not at all for the earth, since even the whole quantity of hydrogen in the ocean is far less than a thousandth of its whole mass. We cannot escape this difficulty by assuming that the earth was too hot to retain hydrogen in its atmosphere, for the changes in the orbit would take far longer than the planets would require to cool. The attractive hypothesis of a resisting medium is, therefore, inadequate.

One naturally asks: "Could not the mutual attraction of the planets themselves have gradually altered their orbits into the present condition?" Not many years ago it was believed that this would be impossible, for the classical methods of the planetary theory indicated that if the orbit of our planet became more nearly circular, those of some other or others would necessarily increase in eccentricity. Recent researches by Professor Brown have shown that this conclusion, though very approximately true, is not absolutely exact. Over a moderate interval, say of a million orbital revolutions, no great and cumulative changes in the orbits of the planets will be produced by their mutual attractions. But when it comes to hundreds of millions of revolutions, we can no longer be sure of this and great changes may occur—though to predict just what they would be is obviously impracticable. It therefore appears to be possible, in the light of modern analysis, that the present orderly arrangement of the solar system is a result of planetary attraction—a sort of settling down into a quiet and long-enduring, though not eternal, state. Whether this has actually happened must remain in doubt; but this very uncertainty removes the last of the dynamical difficulties which seemed such fatal obstacles a decade ago.

The really disturbing unsolved problems that still beset planetary cosmogony are physical. The material ejected from the sun's former companion must

THEORY OF PLANETARY ORIGIN

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society.

have been excessively hot. To get an idea how hot, we may for the moment assume that this companion was similar to the sun in size and mass.

Suppose that Jupiter could be put back into the sun. What pressure would the weight of the added matter exert on the former's surface? An even distribution all over the surface will give the lowest result, for unevenness will raise the pressure at some points though lowering it at others. A very simple calculation shows that if Jupiter's mass were thus spread over the sun's surface, there would be 31,000 kilograms per square centimeter. The sun's surface gravity being 28 times the earth's, the weight of the layer would be 870,000 kilograms per square centimeter and produce a pressure of 840,000 atmospheres. The average pressure in the layer would be half as great. Now, in the interior of a star similar to the sun, the radiation pressure is a small but sensible fraction of the whole. Eddington's investigations show that, even near the surface, this fraction is probably more than 1/1000; that is, in the average of our layer it would be some 400 atmospheres. The corresponding temperature is 630,000 degrees.

INSIDE a smaller star the temperature might be lower, but the conclusion seems unavoidable that the material which now forms the planets, if it once was part of a star, must, before its ejection, have had an average temperature of several hundred thousand degrees, Centigrade. If the matter was pulled out of the star by tidal action, its initial temperature must have been of this order; if expelled by collision, it would have been far hotter, for the stars would have passed one another with a velocity of the order of 500 kilometers per second, and the conversion of the corresponding kinetic energy into heat would produce a temperature of millions of degrees.

The ejected matter, when first exposed to space, would lose heat very rapidly by radiation—mainly of X rays at first, then of ultra-violet light—while at the same time it was expanding furiously in all directions. This would again tend to cool it; but it is not at all easy to see how it could get cold enough for even the most refractory compounds to form and to condense from vapor into liquid until it had expanded so far and reached so low a density that only scattered drops of molten metal or lava would form. A mass as great as Jupiter's might be able to hold itself together but one as small as the earth would have great difficulty in condensing at all. For smaller masses the case is hopeless, and Jeffreys, years ago, concluded that bodies much smaller than the moon could not have formed independently, but must have arisen from the disruption of larger masses.

To follow even roughly the possibilities that may arise in so complex and turbulent a process will tax the utmost resources now available to investigators. But we know enough already of the properties of matter to make a further attack upon the problem attractive. Upon the results of such investigations the progress of cosmogony in the near future seems likely to depend.—*Jamestown, Rhode Island, September 1, 1936*

Everywhere, Eyes Pointed Skyward

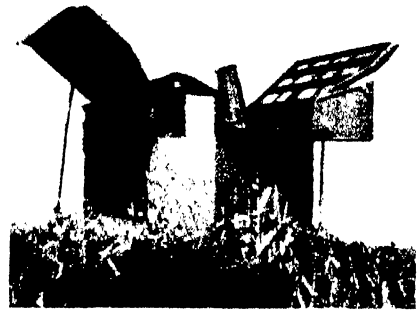


Figure 1: At Potsdam, N. Y.

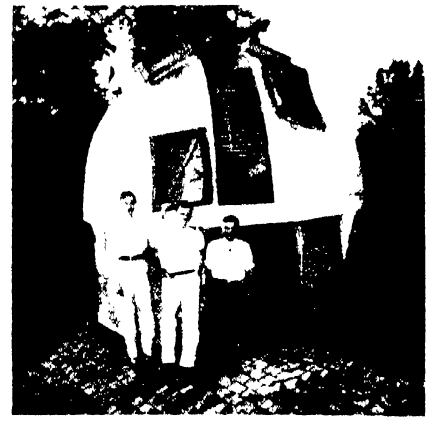


Figure 2: At Atlanta, Georgia

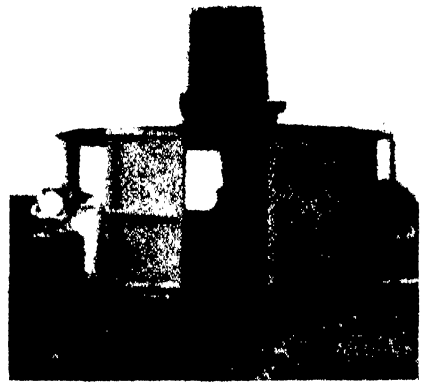


Figure 3: Left: At Davenport, Iowa

Figure 4: Below: At Braddock, Pa.

FROM back yards and rooftops in every state and doubtless every county of the nation, amateur astronomers are nightly pointing homemade telescopes toward the skies. Four small observatories cheaply and simply constructed are shown above. Figure 1 is a housing, nine feet square, made by Frances H. Reynolds, of Potsdam, N. Y. It opens like the two lids of a box and, its owner says, "suits its purpose admirably." Figure 2 is a dome built on a rooftop in Atlanta, Georgia, by three enterprising amateur telescope makers, Williams Scott, Louis Mobley, and Glascock Reynolds. "It cost us 25 dollars," they say. Figure 3 houses a 10-inch telescope and was made by Arthur De Vany and B. A. Nordblom of Davenport, Iowa, while Figure 4 is a square observatory with roll-off roof built on a roof-top by Charles B. Wigels, of Braddock, Pa. Within these simple observatories are home-made telescopes of the reflecting variety which is considerably easier to make, size for size, than the more familiar refractor. Amateurs usually begin with reflectors of six-inch aperture, later making larger sizes.

TAKING THE GUESSWORK

Definite Paths of Operation . . . Pilots Exchange Information on Conditions . . . Trained Meteorologists . . . What the Dispatcher Does

OPERATORS of American air transport planes, from pilots down to the least important of the ground personnel, are rapidly learning how to avoid flirting with dangers in the air; they are also charting definite paths of operation which in recent months have removed more than half the guesswork which formerly attended the dispatching and flying of air transports on scheduled operation.

Let's take this case: Two pilots stand in the operating office of an airline at Oakland, California. One has just arrived from Los Angeles, 330 miles distant; the other is due to leave in 20 minutes for Los Angeles. Together they study two charts: One is a trip log made by the former during flight showing locations and types of clouds, altitude at which he flew, and any other pertinent information, including temperatures at various altitudes; the other is an analysis, based upon latest weather information, of the next projected flight. The second pilot checks the former's report as an aid in arriving at his flight forecast, and soon takes off, knowing precisely at what levels he should fly and what conditions he will encounter en route.

Looking into the cockpit of a transport plane. The pilot is communicating by radiophone with the ground station, receiving instructions and up-to-the-minute weather information

Although we have omitted one man from this brief picture, in the background stands the division dispatcher. Upon him rests the responsibility of actually deciding with the pilot whether a given trip shall take off under certain weather conditions. He, as a combination dispatcher and meteorologist, is the man who is doing the most to remove guesswork from flying.

THE location of all flying equipment on a specific division of an airway is made at the discretion of the dispatcher on duty. In this case such a man is the division dispatcher, who exercises full authority for the clearance of all trips within his sector. This makes it necessary for dispatchers at outlying stations within the division to request approval of contemplated clearances before actually dispatching trips from their respective stations. This is done so that the division dispatcher, the senior authority on such matters, particularly in regard to meteorological and operating problems, may hold the final authority before any dispatching from an outlying station is done.

To illustrate, let us assume that a trip is to be cleared from Fresno, an intermediate station of the coastwise run from San Diego to San Francisco. Conditions may be such between Fresno and San Francisco that it will be necessary to fly on instruments part of the distance, and fly over the top of the overcast for the remainder of the distance. In this event, the Fresno dispatcher notifies the division dispatcher at Oakland that he intends to clear the trip on instruments for the distance indicated and over the top for the balance of the trip. If, in the opinion of the

From the radio dispatch room constant communication is maintained not only with planes in the air but also with the other ground stations of the system

Out of Flying

By T. L E E, Jr.
General Manager, Boeing School of Aeronautics

division dispatcher, meteorological conditions are such that this seems a practical and safe clearance, he will authorize the Fresno dispatcher by radio as promptly as possible that the trip may be dispatched by that station.

He acts not solely upon personal judgment, but in accord with regulations established by the operating company and the Department of Commerce, Bureau of Aeronautics, which require that certain minimum ceilings must prevail, both at the point of departure and the destination, and that conditions prevailing between those points must permit flying. Also, it is necessary under these regulations to specify alternate fields where landings may be made in the event the weather changes during the flight to such an extent that landings cannot be made according to the minimum prescribed.

Having determined that the flight may be made in safety, in the face of an overcast condition prevailing from Fresno to Tracy, the dispatcher hands the pilot his clearance.

"Flight is authorized from Fresno to Oakland, with San Francisco stop, on instruments from Fresno to Los Banos, over the top Los Banos to Tracy with alternate fields Sacramento and Livermore."

This assumes, of course, that conditions prevailing at Sacramento and Livermore will definitely permit landings there in accordance with Department of Commerce and company regulations. The clearance sheet also indicates what the ceilings are at various points of observation en route, as well as temperatures, wind velocities and directions, dew point and visibility, and any other pertinent information regarding the weather. Also, at the top of the clearance, space is provided for vital information relative to gas supply and cargo and passenger load.

After the trip has departed from Fresno it is then under the complete control of the division dispatcher at Oakland. Any changes in either the route or method of flying which may subsequently alter the weather conditions will be authorized by the division dispatcher by radio directly to the pilot in flight. The Oakland dispatcher is in constant communication with the United States Weather Bureau at the Oakland Airport. This supplements the customary hourly and three-hourly service rendered by the Weather Bureau on the teletype system directly to the station.

Dispatcher communicating with plane and second observer to aid a pilot flying over a fog bank

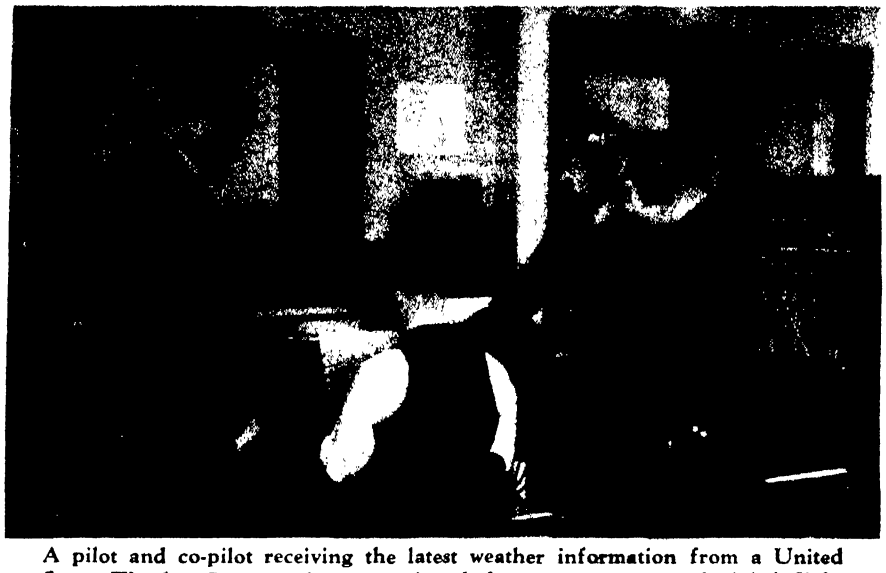
THE dispatcher is required to consult the government weather authorities in his sector as frequently as is necessary in order to safeguard the operation. This he is expected to do, irrespective of his own desire to rely solely upon his decisions, in order to secure their forecasts, advices, and interpretations to avoid overlooking any pertinent factors which may have a bearing on the flight but which might be missed through individual analysis on the part of the dispatcher.

In the earlier days of air transportation, relatively little consideration was given to the importance of dispatching, especially from the standpoint of meteorological observations. Consequently, most of the responsibility for determining weather conditions rested with the pilot.

Now we witness an important change. At all terminal stations there have been assigned meteorological experts who function as assistant dispatchers. These meteorologists are assigned with a view to building up in the dispatching personnel a more thorough understanding of theoretical meteorology. All the dispatchers have a thorough practical understanding of the weather situations and are now acquiring additional theoretical knowledge which will make them better fitted to handle their work. The meteorologists are also available to discuss weather situations and to assist in the analyses with dispatchers and flying personnel.

The meteorologist naturally must have a thorough background of tech-

Calculating the proper cruising speed and altitude for a scheduled flight. Forecasts of flights are made before taking off, using the best available weather data



A pilot and co-pilot receiving the latest weather information from a United States Weather Bureau teletype receiver before starting on a scheduled flight

nical training in order to understand the scientific elements concerned in weather interpretation. It is his duty to act in an advisory capacity both with pilots and the dispatcher under whom he functions. After completing his training at some institution such as Massachusetts Institute of Technology or California Institute of Technology, where he has taken a thorough course in engineering and advanced study in weather phenomena, he receives further indoctrination in airways weather analysis at the Boeing School of Aeronautics. The course in dispatching and meteorology given here combines instruction in these two subjects, is based on information gathered over a long period relative to weather problems encountered in flight operations, and requires for entrance a four-year course in aeronautical or mechanical engineering. By this means the men who will control all flights, assisting pilots in making flight decisions, will be versed in meteorology, air law, avigation, communications, instruments, meteorography, aerodynamics, psychology, and safety.

TAKING the guesswork from flying today begins not in the operations offices of the airlines, but in the preliminary instructions given to student pilots and young men training to become dispatchers, as well as to mechanics, radio operators, traffic employees; in fact, to all who will hold jobs connected with aviation.

The Boeing School of Aeronautics pioneered in starting flight instruction "under the hood." Here in a dramatic way is guesswork removed. For periods up to 20 hours, selected students receive flight instruction in a darkened cockpit by instruments and radio, never once being permitted to see the earth.

Today's crop of pilots learns, in the course of 20 hours, to believe their instruments and not to trust their feelings, they acquire some facility for locating and following radio beams, and they learn to apply a scientific attitude toward the handling of airplanes.

When one of these boys completes his school course and becomes co-pilot on the airline, he finds further proof that nothing is left to chance. He finds the dispatcher-meteorologist, acting as division dispatcher on day duty, supervising all scheduling of crews. He finds that superintendents of flying (chief pilots) give advanced instruction in avigation, instrument flying, and other subjects in order to keep all flying personnel equally proficient. Further, he learns that the dispatcher makes sure that all operations are conducted within the reliable limits of aids, abilities, knowledge, and experience.

Further, the dispatcher takes the guess out of a scheduled flight because he knows the personnel and weather conditions, and also because he is familiar with the terrain over which the flight is to be made. To achieve the latter knowledge, each dispatcher makes periodic flights at least every 90 days over all sectors controlled by his authority. On these trips he occupies the co-pilot's seat on a regular scheduled flight, and makes a close inspection of all intermediate landing fields and terminals en route.

WHILE this type of dispatching is new, there have been several instances where it has given positive control from the ground over ships in flight. Such control commences with the working out of flight analyses, previously mentioned. These analyses are based upon the direction and velocities of existing winds and predicted weather situations, distances between stations, and upon the speed the pilot plans to maintain at various altitudes according to cloud conditions.

Usual operations are, of course, far more simple. After the pilot "draws the picture" of his projected flight, he and the dispatcher agree upon the plan. During flight, the pilot draws a second picture, this revealing his actual flight and conditions encountered. This practice helps make control more positive and guides pilots taking off later.

Proper dispatching and accurate prediction of conditions aloft has done more to take the guesswork from flying than any recent development. Furthermore, older pilots find that, knowing exactly what they will encounter, they not only complete their schedules with less fatigue than formerly, but usually arrive at their destinations at the scheduled time or slightly in advance. Thanks to the dispatcher, who is now becoming a meteorologist as well, schedules can be run in safety and with a precision heretofore impossible.

Dispatcher and pilot checking the weather map. In the background are diagrams that show the weather conditions encountered during recently completed flights

A rather large basin of the Albert Canal below Liége at Lanaye. Note the way in which its banks are concrete-lined and the manner in which the hill at right has been cut away to avoid a sharp turn

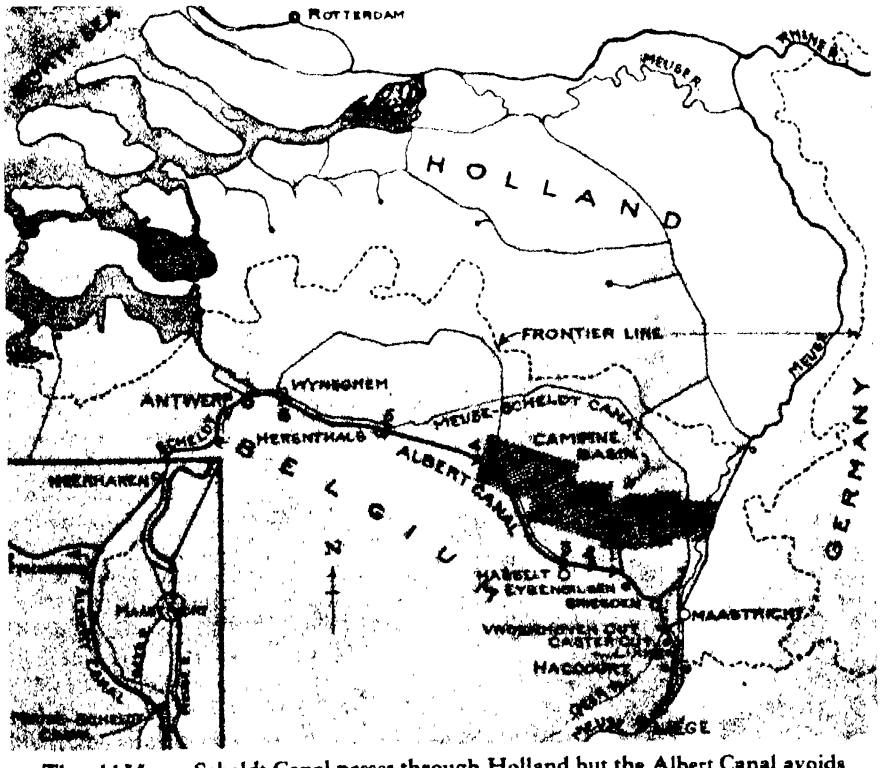
An All-Belgian Canal

Albert Canal . . . Started 1930 . . . Will Cost About $80,000,000 . . . Be Completed Next Year . . . Gigantic Engineering Job . . . Economically Significant

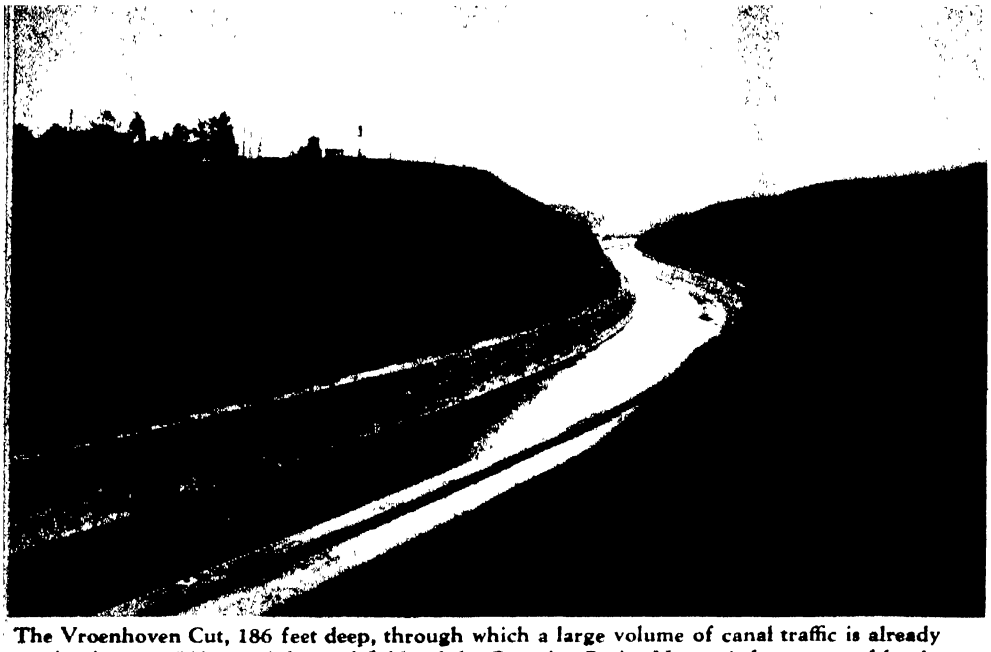
By R. G. SKERRETT

CONSTRUCTION of the Albert Canal across Belgium, linking the great Port of Antwerp with the nation's industrial center at Liége, is the outstanding task now engaging the engineers and contractors of that enterprising country. When completed next year, as scheduled, the project will have entailed outlays totaling about 80,000,000 dollars. The potential benefits, which will be many and varied, will richly compensate for the money spent upon that waterway. Building of the Albert Canal has called for the mastering of numerous monumental difficulties; yet, despite the obstacles interposed by nature, the work has gone forward steadily and even rapidly since it was started in the first half of 1930, thanks to the wide employment of typically modern machinery wherever time could thus be saved.

Belgium's extensive network of railways and natural and man-made waterways have long been used intensively in handling commodities for domestic consumption, for export, and for incoming products originating abroad. Low-cost water transportation plays a prime part in enabling Belgium to hold her own in international commerce; one of the principal reasons for the Albert Canal is to help domestic industries to make the most of the nation's natural



The old Meuse-Scheldt Canal passes through Holland but the Albert Canal avoids Maastricht (note inset). Numerals on the route of the new canal mark locks



The Vroenhoven Cut, 186 feet deep, through which a large volume of canal traffic is already moving between Liége and the coal fields of the Campine Basin. Note reinforcement of banks

resources, to improve her position in world trade, and to aid her otherwise in meeting the changed conditions of the last two decades.

From end to end, the Albert Canal will be about 76 miles in length. Its route traces a generally southeast course from Antwerp until it nears the River Meuse in the vicinity of the Dutch frontier city of Maastricht, where the canal swings abruptly to the south and follows the left or west bank of the Meuse to the terminal point at the Monsin Basin, close to and downstream of Liége. The course of the canal is entirely within Belgium, which is not the case with the canal that has linked the Meuse with the Scheldt at Antwerp for more than three quarters of a century. Craft bound between Antwerp and Liége have had to pass through a bottleneck, 5.28 miles long, in approaching and leaving Maastricht; and that run through alien territory has involved many sharp turns, the opening of numerous swing bridges, passage through several tunnels, moving through three locks at changing levels, and dealing with officials at no fewer than four customs houses.

DEPENDING upon the volume of traffic threading the bottleneck, the stage of water in the river, and other circumstances, that part of the trip has taken from three to eight days, while the entire run between the two terminal Belgian cities in question has averaged not less than 12 days. Certain controlling conditions have denied the use of the old canal to vessels carrying more than 450 tons of freight, while Liége has been accessible to much larger German and Dutch barges traveling upon the canals and the canalized rivers of Holland and the Rhine, with the Dutch Port of Rotterdam as their contact with seaborne trade. To this extent Antwerp has been placed at a disadvantage in handling trade between Liége and the markets of the world. Moreover, the old Belgian canal draws its water from the Meuse River at a point on the eastern frontier where an agreement between Holland and Belgium has for many years limited the diverted flow—the restriction being especially hampering to canal traffic at low stages of the Meuse.

The Albert Canal will obtain its water from sources in the valley of the Meuse and wholly within Belgian territory, so there is assured at all times an abundance of water not only for the canal but for the irrigation of hitherto undeveloped sections of the country and for supplying the collieries of the Campine Basin with essential water for industrial purposes. The old Belgian canal circles too far to the north of the Campine coal fields to serve many of the collieries in that part of the Province of Limburg, but the route of the Albert Canal has been arranged to aid that area and therefore prospectively lead to a tremendous industrial upbuilding of that region. Liége owes its industrial supremacy to its great local deposits of coal; the availability of that fuel and iron ore in the valley of the Meuse upstream of Liége has brought about the industrial growth of Seraing, Huy, Namur, Charleroi, and lesser communities noted for their metallurgical, glass, and other manufactures dependent upon large supplies of raw materials.

Belgian statesmen and leaders envision a duplication in the Campine Basin, contiguous to the Albert Canal, of what has taken place at Liége and elsewhere in the busy valley of the Meuse. Furthermore, they count upon the Albert Canal to strengthen the bonds between Flanders and the Walloon country of the Meuse by promoting closer relations and by breaking down those differences that have long existed because of the two languages in use and the contrasting historical backgrounds of the peoples of the eastern and the western sections of the land.

The new canal is of dimensions that will accommodate barges of even 2000 tons capacity; and the banks of the waterway are so formed and so reinforced as to permit vessels of 1350 tons to travel at full speed without endangering the flanking structures of the canal. When finished some months hence, this splendid artery of trade will make it possible for craft to cover the run between Antwerp and Liége in less than four days. The Albert Canal has but six locks while the old canal has 24 locks; the new route is actually 20 miles shorter than the old one, but in effect it will be 75 miles shorter because the passage of each lock is equivalent to the time required to make a clear run of 3.10 miles. It is estimated that the annual volume of traffic on the Albert Canal will be not less than 15,000,000 tons—three times as much as is now carried in a year by the old water route between Liége and Antwerp.

IMPROVEMENTS made in canalizing the Meuse, from just below Liége and extending upstream for a considerable distance, totally altered the problem for the engineers when the building of the Albert Canal was authorized a few years later. Those changes established at Liége a water level nearly 184 feet above the normal water level at the Port of Antwerp. That head of water has enabled the designers of the Albert Canal to traverse far easier high ground along the route chosen and has been especially helpful in carrying the canal across the dividing ridge that lies between the basins of the Meuse and Scheldt rivers. There is no intermediate crest at any point along the canal; the water flowing into it from the impounded Meuse at the Monsin Basin just below Liége flows thence until it is discharged into the Scheldt, making six drops in its course at the six locks that successively step down the water level about 33 feet at each change, with the exception of the lock just upstream of Antwerp, where the change is 18.7 feet. The usable chamber length of each of the several locks is 446 feet, with a width of 52.5 feet and an available depth of water over the sills of 11.5 feet.

Unquestionably, the most difficult stretch of the Albert Canal is that covered by the 35 miles from Liége northward and westward, along which the new waterway follows the valley of the Meuse and then cuts through a ridge and reaches the eastern limits of the basin of the Scheldt. A considerable part of that section of the canal is carried at a water-level elevation 32.8 feet above the normal nearby ground surface. To hold the canal aloft there, the engineers have had to resort to a form

of wall-dike of massive structure, and along one side, at least, to add an expansive reinforcement consisting of a backfill of many millions of cubic yards of earth. The new canal for some of this part of the run follows the course of the old canal but envelops the latter and submerges it more than 23.75 feet. Within a comparatively short distance of one another and but a few miles northward of Liége, the line of the Albert Canal crosses two ridges where tremendous cuts, respectively 213.25 feet and 187 feet deep had to be excavated through difficult ground—one known as the Caster Cut and the other called the Vroenhoven Cut.

The Caster Cut is through high ground lying between the Meuse and the Geer. The formation is basically of tufa stone overlaid with a deep stratum of gravel, most of the cut, however, being through stone which stands up well when exposed. The Vroenhoven Cut presented more of a problem, because the upper half of the excavation was in the much less stable gravel, and the cut had to be much wider in that material to prevent slides. The cut involved the removal of a total of 23,540,000 cubic yards of rock and gravel, which is three times as much material as had to be dug and disposed of in the case of the Caster Cut.

THE heaviest and hardest work on the Albert Canal has carried that waterway in a single reach all the way from Liége northward and westward to the vicinity of Genck, a distance of 23.61 miles. Genck, at the southern edge of the Campine coal fields, is now linked by a branch canal, 10.56 miles long, with the new trunk route. Liége and its adjoining industrial region are thus connected with the vast fuel resources of the Province of Limburg by an unbroken water route 34.7 miles in length. All bridges crossing the Albert Canal are high fixed structures that assure the free movements of shipping, and some of these structures are entirely welded and represent a distinct advance in the art of bridge engineering.

The first lock on the new canal, after leaving Liége for Antwerp, is about three miles westward of Eygenbilsen, whence the waterway follows a course generally northwest to Antwerp. Locks Nos. 2 and 3 are at intervals of approximately three miles; and between Lock No. 1 and Lock No. 3, which is at Hasselt, the change in the canal level is virtually 100 feet, this pronounced step down occurring where the canal leaves the valley of the Meuse and reaches the eastern area of the Scheldt basin. After leaving Lock No. 3, bound for Antwerp, a vessel has a clear run of 18.64 miles before entering Lock No. 4, there descending 33.13 feet to make the run of 9.5 miles to Herenthals, where Lock No. 5 is located. A lateral lock at Herenthals permits inter-communication between the old and the new canals. Between Herenthals and Wyneghem, the canal reach is 16.2 miles long; and through Lock No. 6 at Wyneghem a barge enters tidal waters five miles upstream from Antwerp. The foregoing details should make it clear that most of the reaches on the Albert Canal are of considerable length and will permit traffic to move onward at a good and steady speed. At five of the locks, the average change in level is slightly more than 33 feet, while at the Wyneghem lock the lift is but 18.7 feet. Depending upon the change in level, the locks can be emptied and filled in from eight to ten minutes. At each station, there are twin locks, so that upbound and downbound traffic can be handled simultaneously.

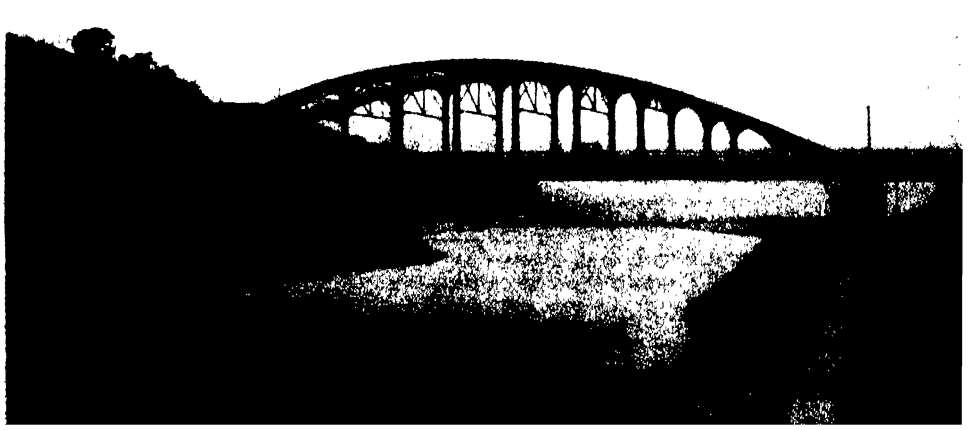
The twin chambers are interconnected so that water can be discharged from an emptying chamber into a filling chamber, thus economizing in the use of water. All the locks are typically up to date, and are operated electrically so that passage through them is rapid.

At Eygenbilsen, the canal crosses the final ridge between the basins of the Meuse and the Scheldt, and the cut there is through high land that was excavated to a depth of nearly 98.5 feet. The course taken was the shortest and entailed less digging than elsewhere. The task, nevertheless, taxed the ingenuity of the engineers because the ground to be traversed contained beds of clay and sand near the surface that varied in thickness from 16 feet to 45 feet and were saturated with water. That unstable ground rested on soft clay; and the ground had to be freed of that water to consolidate the formation and to permit the excavation to be carried to the prescribed maximum depth without fear of the slopes slipping into the cut. Without dealing with the technicalities of the problem, it is enough to say that the responsible engineers devised unusual and effective means of progressively draining away the troublesome water and of radically altering for the better the capacity of the ground to stand unmoved after the cut was completed and the canal filled with water.

In digging the Eygenbilsen Cut, as elsewhere on the undertaking, American machinery has been employed to advantage. The Belgian engineers have done numerous things by which engineers elsewhere may profit; those technicists have been equally alert to what has been done abroad in carrying out great public works. As might be expected, the Albert Canal has been linked by large modern locks with some of the Dutch canal systems tributary to the Meuse and the Rhine, so that both Antwerp and Liége will be accessible to the largest of the German and Dutch barges. This will improve commercial intercourse between Belgium and the interior of central Europe and will widen Belgium's trade in both raw and manufactured commodities, incidentally providing additional outlets, at low cost of transportation, for the coal mined in the Campine Basin.

THE Albert Canal was taken in hand by Belgium largely as a means of affording employment directly and indirectly to tens of thousands of her people in a period of economic stress. The money thus spent on the canal will not be of fleeting benefit but will have given Belgium a lasting monument to her foresight and a means of contributing to the prosperity of her people for many decades to come. Both Antwerp and Liége will register immediate gains, while Antwerp will possess added advantages over Rotterdam in world trade, through the broadening of her water links with an immense hinterland, which includes the eastern part of France.

Modern to the last degree: the latest in canal construction and a novel type of bridge of all welded steel which spans the canal in the vicinity of Lanaye. The clean lines are noteworth



New Aids For Criminology

IN the apartment of a criminal suspect, two operatives from the Los Angeles sheriff's office found a finger print on a mirror set into a door. Unable to remove the mirror and not wishing to leave any indications that they had visited the place, one hurriedly took from his pocket a glass tube and began blowing against the print. Quickly a brown image formed, whereupon the other officer pressed a small square silver plate against the image, carried the plate to a window where he exposed it momentarily to sunlight, and as quickly the officers departed from the premises.

Again, in Los Angeles, counterfeit coins were taken from the tool box of a suspect's automobile and from his daughter, and raw metal resembling that contained in the coins was found on the gas stove in his home. Were they alike or different? Later that day spectrographic analysis was made of the elements contained in the three specimens; the pictures projected on a screen from a projection comparator, a new device, which permits rapid analysis of spectrograms, proved them to be alike.

Seemingly unrelated, these two incidents mark a new phase in the unceasing war on crime. They had their beginnings in Pasadena, California, where a few months ago was formed a scientific committee to advise with and aid the police department in criminological investigations. On that committee are scientists who have had extensive training in chemistry and physics.

Two problems particularly were submitted to the members of this committee. These were: The development of latent finger prints, so necessary for identifying criminals long after the commission of a crime; and the identification of various materials found at the scene of a crime, such as metals, ceramics, cosmetics, paint, and glass. By proving that the elements in a cosmetic smear on an ether mask were identical with powder carried in the patient's vanity case, for instance, a given practitioner might be connected with an illegal operation. Moreover, a speedy method of comparing these substances was needed.

The scientific advisers on this committee, inaugurated by Lt. A. R. Sears, are John McMorris, Ph.D., chemical consultant, and William W. Harper, consultant in physics. Individually, they focused the facilities of their respective fields on these problems.

Blowing iodine fumes against a finger print on a paper surface. Dr. John McMorris looks on. *At right:* A finger print "raised" from a mahogany surface by the use of this method

Dr. McMorris recognized that commonly practiced methods for developing finger prints have individual defects which forbid the use of certain methods in particular cases; further, that it has been difficult, and usually impossible, to develop latent prints on greasy surfaces, such as polished table tops, mottled backgrounds, and printed pages. More prints, he contended, have been ruined by the powder method than have been saved, particularly when more than a few hours old; likewise, the well-known silver nitrate method not only is technically difficult, but also is applicable to only a small number of surfaces.

He recognized that the iodine technique possessed certain advantages, but to date had been impossible of application in the majority of instances. In the past, finger prints have been "fumed" by placing the object within a box and filling the box with fumes. This brought out the image, but too often destroyed the evidence itself.

Dr. McMorris applied well-known chemical principles and has developed a method which makes use of the conventional iodine method, but in a new way. Since most objects which could bear a latent finger print are too bulky for enclosure in a container of iodine vapor, he developed an instrument for fuming *in situ*. This consists of a 4-inch length of glass tubing, constricted at one end for a rubber tubing connection. Into the large opening he stuffs a pad of glass wool, pours in a half-teaspoonful of iodine crystals, and pushes in another pad of glass wool to hold the crystals within the tube. The breath can be blown through the tube, carrying iodine fumes out the large opening, the iodine being warmed by the hand if greater efflux of vapor is desired.

AS stated, the instrument has its widest use on latent finger prints, particularly on greasy objects. (Latent prints consist largely of skin debris from which the oil has dried away, and possibly some chemical residue from perspiration.) Fuming is simple.

"The large opening is swept over the surface being examined," Dr. McMorris explains the technique, "very much in the style of a painter spraying a surface with lacquer. Holding the instrument about half an inch from the surface will give a good fume density and also good coverage. In actual tests, both sides of a sheet of letter-size paper were 'prospected' for prints in less than one minute.

"When a latent print is discovered,

the area where it resides can receive a more liberal fuming to yield the maximum of contrast. The amount of time required for fuming a single latent varies from one second to a fraction of a minute. Condensing of mist on glass and metallic objects is avoided by pouring a teaspoonful of anhydrous calcium chloride into the tube before introducing the iodine crystals and separating the two substances by glass wool to prevent mixing. In this way dry, warm air is forced through the crystals."

Given the developed finger print image in a beautiful iodine or brown sepia, then what?

By Dr. McMorris' method, the image is then "transferred" to a small sheet of silver, very smooth and free from scratches but not mirror-polished. Mirror-polished silver sheet pickled in sulfuric acid, which produces a silver gray matte surface, is now being used. The sheet is pressed against the image for one to 10 seconds, the time depending upon the amount of iodine taken up by the latent print. Following this "printing" process, the image on the silver is developed by exposure to direct sunlight for 30 seconds or so, or exposed at close range to a Photoflood bulb. Ordinary electric bulbs have been found to be too weak to be useful. Either the silver sheets may be preserved, if protected against strong light, or the images photographically preserved by copying the prints as they appear on the silver. Prints may be removed from the silver by polishing with silver whiting or opticians' rouge. As many as five transfers have been made from one latent image, and the last

was as good in all details as the first.

Many types of surfaces have yielded prints to the new method—waxed and polished furniture, greasy enameled kitchen stoves, cotton and silk cloth, several kinds of hardened paper (not newsprint), glass, and mirrors.

The iodine-silver method has the advantage of producing a number of prints without destroying or marring the latent

Finger Prints "Raised" With Iodine . . . Spectrographic Analysis of Materials . . . Tiny Traces Yield Evidence . . . Contribute to Conviction

By ANDREW R. BOONE

image. In a darkened room, as previously explained, an image may be "lifted" from a mirror without removing any part of the latent and without disturbing the surroundings. The secret of its success lies in the fact that the iodine combines with the silver to produce an image in silver iodide, and on exposure the silver salts are decomposed by ac-

"Developing" a finger print after pressing a silver plate against the iodine fumed surface. *At left:* Three finger prints registered on a silver plate, after a short exposure to light

tinic light. What the operator then sees is the decomposed silver, for the iodine has now disappeared.

While this method is quite new, it already is being used by seventeen California sheriffs' and police departments, as well as in Honolulu.

Finger prints are, however, only one form of evidence left by a criminal. Often other materials connect him with a crime. Analytical application of the spectrograph to industrial problems has led the Applied Research Laboratory of Los Angeles to the development of a special grating type of instrument. In addition a dual projection comparator was developed by means of which spectrograms of both metallic and non-metallic elements can be analyzed in a few minutes. This method not only increases the speed with which identifications can be made, but it also supplies a permanent record and removes the necessity for repeated qualitative chemical analyses, which at best often are in error. With these instruments, Mr. Harper, in association with the Applied Research Laboratory, has developed valuable new technique in the spectrographic identification of criminal evidence.

Recently a Los Angeles man faced a murder charge after a patient succumbed following an alleged illegal operation. He denied having performed the operation. In his rooms, however, was found a crude ether mask made by fitting gauze into a sink strainer. On the gauze were found red splotches, apparently rouge from the cheeks of some individual. An analysis of 12 contaminated fibers, each one inch long, proved the contamination to have come from cosmetics. Dustings from the deceased's compact checked exactly, except for the additional presence of nickel and tin. Examinations of the compact showed the surface worn away and explained the presence of these two metals. Four similar types of powder were purchased and analyzed. These showed no similarity. Thus the patient's presence under the ether mask, ownership of which was admitted by the accused, was proved.

The method of heating the materials and photographing their spectrum is of interest. In the case of small amounts of metal, such as borings from a bogus coin and minute traces such as the cosmetics, small quantities are placed in cavities of a number of the lower graphite electrodes of a multiple electrode arc unit. Each electrode is successively arced for one minute, the opening in the grating through which the light reaches the film being adjusted for correct exposure. Between every two exposures iron electrodes replace the sample electrodes and an iron spectrum is photographed. In five to ten minutes, several spectrograms of sample and calibration iron may be made. Film is developed and fixed in another five minutes, after which it is dried.

"After obtaining these spectrograms of the samples to be analyzed," explains

Taking borings from a bogus 50-cent piece. The scraps of metal are to be analyzed spectrographically. *Right:* Placing the metal on one of the electrodes of a multiple unit arc, where it is vaporized and emits light characteristic of all the elements present in the metal. *Below:* The grating spectrograph ready for use, the arc unit being in the right foreground. The semicircular arrangement permits photography of various regions of the spectrum by moving the slit and the arc

Mr. Harper, "a method of measurement and interpretation must be employed to extract from the film the greatest amount of information in the least time. To facilitate this the dual projection comparator has been developed. It employs the well-known fact that certain lines of an element's spectrum are the most sensitive and that the identification of a few of these lines is a certain method of detecting the presence of that element in the sample. This premise is used in the preparation of a master film consisting of an iron spectrum and three or four lines of each of the elements detectible marked thereon and designated according to element. Thus a total of some 210 designated lines appear on the master film.

"By dual projection a small portion of the film bearing the sample's spectrum is shown directly over a portion of the master on a 24 by 30 inch screen, at a magnification of 48 diameters. After aligning these two films by means of the iron spectrum on each, the operator, in making an analysis, merely notes coincidences between lines in the sample spectrogram and lines on the master film. To observe and tabulate the elements found in an ordinary metallic alloy requires from fifteen to twenty minutes. Doubtful coincidences occur only rarely with an instrument of high resolution and always may be checked at other lines.

"In general qualitative work the intensities of the various lines are weighted visually to furnish an approximate quantitative estimate of the amounts of the elements present. In more accurate quantitative work the length of the space between line endings is read on a vertical scale at the same time the qualitative check is made. Thus with a single instrument all tedious measurements have been eliminated with a consequent reduction in the personal element. In this manner analytical speed and accuracy have been increased many fold.

"Before considering the question of the multitudinous applications of a complete set of instruments of the above type, a discussion of the sensitivity of the grating spectrograph would not be amiss. Since no quartz-air interfaces are used in the spectrograph proper, stray reflected light does not limit the sensitivity as is often the case in Littrow mountings. Also, the higher resolution and dispersion affords greater general operational sensitivity.

"IN dealing with metallic alloys, often no indication is given as to the alloy type, and the chemist must start at the beginning and make a tedius and accurate qualitative analysis before attempting quantitative separations. Often in making these separations interference occurs between various elements present, especially in complex alloys, and unless extreme care is exercised, minor constituents may be easily overlooked. With spectrographic equipment of the above type available, the first step is to make an arc analysis of the material. In examining the spectrogram with the projection comparator, the operator prepares a list of all the elements detectible. At the same time he notes the intensities of the various lines used for identification, and from a table of factors calculates the approximate quantity of each element present."

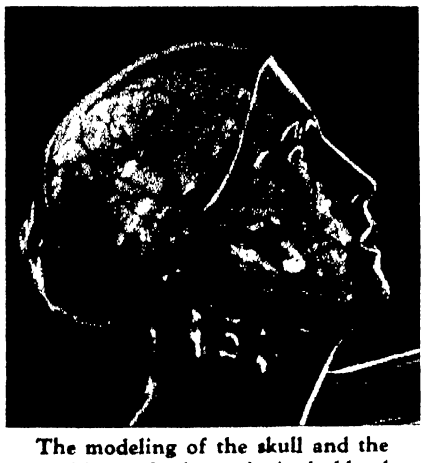
Such qualitative spectrographic analyses are of great assistance to the police, both because of their accuracy and the fact that results may be obtained and compared within 30 minutes. In the case of the counterfeiter, the method withstood cross-examination, was admitted in evidence, and contributed largely to his conviction.

Dual projection comparator throws two spectrograms on a screen where they may be accurately compared

A Woman You Can See Through

THOSE who have observed the exhibition of the Camp Transparent Woman at the New York Museum of Science and Industry at Rockefeller Center state that they are amazed at the ignorance of the human anatomy displayed by visitors.

This figure was constructed in Germany, brought to this country by Mr. S. H. Camp, and, after the present exhibition, will make an educational tour of 100 cities in this country over a period of more than two years. Showing details of body structure, position of organs, blood vessels and the like, it is made of a new transparent material called "cellhorn." Lights are included in most of the organs so that a lecturer may easily call attention to their location. Four such human figures have been constructed, this being the first female figure. It required 23 months to make and employed the services of many people, including medical authorities and scientists, artists, sculptors, laboratory workers, wood carvers, etc.



The modeling of the skull and the position of the principal blood vessels are shown in this view of the head of the transparent woman

The completed figure, with its arteries and veins, before the various organs are attached. When complete, the figure will be covered with a transparent "cellhorn" shell

The completed figure in its "cellhorn" body-outline shell which is made in two pieces so that it may be opened for replacing lamps or for minor repairs. The shell was made from a plaster cast that was, in turn, made from a living model

One of the many specialists working out in careful detail the master molds for the transparent organs

Perfect reproductions in "cellhorn" of the organs of a woman's body. These include several of the glands, the brain, liver, kidneys, heart, there being a total of 21 organs

A Find That Did Not Ring True

A Problem Solved, Though Solved Negatively... The Story Is a Naïve One... Mr. Brennan's Quick Irish Imagination... Practical Joke, WPA Workers

By ALBERT ERNEST JENKS
Professor of Anthropology, The University of Minnesota

A FEW scientists of the old school were said to lack a sense of humor, but today science is no longer on the defensive, and so it feels it can see the point of a joke as well as "the next fellow"—for example, as well as an editor!

An Oregon Irishman hoaxed a local amateur archeologist in Minnesota and the amateur archeologist reported the find to this magazine. His article—a brief one of one-page length—was published in the June number, and it asserted that the dating of man's sojourn in America had been pushed back to more than 20,000 years ago by the Minnesota finds described. The author was a superintendent of schools and a doctor of philosophy, which appeared to lend credibility to his article.

Just what happened afterward is told in the accompanying sequel, written by a noted anthropologist-archeologist who uncovered the hoax. Let us not "pick on" Mike Brennan, the villain of the plot, for his prank—unless we are sure we would ourselves resist a similar temptation.—*The Editor.*

THE documented history of the find reported in Scientific American, June, 1936, begins December 27, 1935, when Mr. Oscar B. Larson, Village Clerk of Biwabik, wrote a letter to the Minnesota Historical Society. The Larson letter follows:

"You may be interested in the fact that a number of Indian relics including arrow heads, spear heads, and one tomahawk head made of flint, jasper, and obsidian have been found in a peculiar geological formation south of Biwabik.

"I would estimate that about 20 or 30 of these have been found to date.

"They were dug up by WPA road workers while cutting through a hill. They were found approximately eight feet under the top layer of soil. The top soil is of clay and the relics are found in a sandy ground mixture that lies directly beneath.

"Those who are familiar with Indian mounds in this vicinity definitely claim this is not a mound."

Mr. Larson's letter was forwarded to me December 30 by Mr. Willoughby M. Babcock of the State Historical Society, who wrote that the discovery sounded like an interesting one and that he passed the information on for our files.

On January 3, I acknowledged the Babcock letter and wrote Mr. Larson the following letter:

"A copy of your letter written December 27, 1935, to the Minnesota Historical Society, Saint Paul, has been forwarded to me by Mr. Willoughby M. Babcock, Curator of the Museum and Archeologist of said Society.

"At this time I do not see how we can come to Biwabik, though the most strenuous effort would be made to do so if conditions seem genuinely to be what they appear.

"Perhaps you can help during the next three days in getting us some accurate information. Did you see the flints in place or can you give names of the best educated and most reliable persons who did see them in place? Can you get the information as to what became of the flints, etc.? Also, was the position in which these '20 or 30' flints were found entirely obliterated by the digging of the road workers or does it extend into undisturbed gravel at one side of the road cut? Also do you know if any surveys were made to ascertain location; also whether any photographs were taken so the relation of the clay and the sand immediately beneath shows?

"Any other more detailed information that you can give regarding it we will greatly appreciate."

Mr. Larson made no immediate acknowledgment of my letter and later told me he had turned it over to Superintendent C. E. Hagie of the public schools of Aurora, a neighboring town. Superintendent Hagie wrote me regarding the matter on January 13. Thereafter a few letters of no significance in the history of the case passed between us. Later he twice visited the Departments of Anthropology and Geology of our University.

On March 27, 1936, with Mr. Lloyd A. Wilford, Department of Anthropology, University of Minnesota, I visited the site with Dr. C. W. Bray and Mr. Oscar B. Larson, both previously mentioned.

During the winter of 1935 and '36 and still on, a WPA project employing local men has been getting gravel for nearby roads from an extensive deposit of sand, gravel, and clay in a section of a future highway in Biwabik township of St. Louis County, Minnesota, close to the eastern end of the world-famous Mesabi iron range.*

The WPA men were at the site on the date of our visit. Men who had rescued the artifacts in December fortunately were present March 27 and verified the three different loci, some 12 or 15 feet apart, from which the artifacts had been taken.

The site of the find is in the St. Louis drainage. The cut in the roadway clearly shows the superposition of the Keewatin till over older outwash of the Wisconsin glacier.

THE several workmen who found the "flints" reported them as immediately beneath a layer of red clay (Keewatin drift, stained red by the local iron ore) some two to three feet thick, and as in the upper few inches of a layer of sand and gravel (apparently the earlier Patrician drift of the Wisconsin glacier). The "flint" artifacts therefore seemed to be datable, and datable, probably, with greater precision than any now reported of glacial age—that is, provided they had been left by their original, prehistoric owners where reported as found.

On our March visit, excepting where men were working, the ground was covered with snow, and was frozen many feet deep. Sand and gravel removed by the crew were blasted loose with dynamite. Within three feet laterally of the spot from which most of the recovered flints had been secured, we broke loose a piece of frozen matrix weighing about four pounds. This we took back with us.

*To be more specific, the site is some seven miles southwest of the village of Biwabik and in the roadway between the S.E. quarter of the S.E. quarter of Section 28, Town 58, Range 16 (on the north side of the roadway) and the N.E. quarter of the N.E. quarter of Section 33, Town 58, Range 16 (on the south side of the roadway).

Again, June 5 to 7, I visited the site with my colleague, Dr. George A. Thiel, geologist. The gravel crew was again working. All the information we then secured was confirmatory of our earlier information. Samples of till were secured by Dr. Thiel and taken back to the University. Their chemical and petrographic analyses showed the clay overlying the level bearing the "flints" was Keewatin drift and the sand and gravel immediately beneath the clay showed many characteristics of the Patrician drift. Geologically the setting of the find seemed to be both clear and of unique importance.

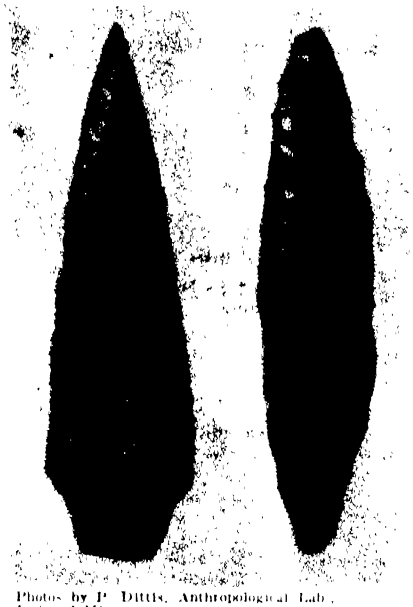
Archeologically the find did not ring so true. To be sure, extremely interesting aspects of the problem lay in the fact that all the artifacts obtained by the WPA men are obsidian—which material is not known to have been found in Minnesota except rarely in the form of isolated artifacts. Most of the Biwabik artifacts are patinated and a few are so completely obscured by patina that their nature can not be determined by eye or glass. Again, several of the artifacts carry the scars of the typical Yuma-type of diagonal chipping. The spear head shown at the left in the accompanying illustration reveals clearly the diagonal scars.

BUT, though the first "flints" we saw from the site were large, one a knife and the second a spear head, 14 of the 17 I have now seen are of types known as "arrowheads" (most of them are illustrated in the June article of Scientific American). Arrowheads! Nowhere in the world is the bow-and-arrow invention dated as early as in Paleolithic time. How, then, could one consider "flints" in the form of arrowheads as of glacial age? But the problem was unsolved and demanded solution.

Then came Superintendent Hagie's article in the June Scientific American, which contains this statement:—"Mr. Hill, my research worker, and I, are convinced that the coarser sand represented the filling material of a burial in the stratified sand, at a date before the last glacial period."

With such definite interpretation of the site, the solution of the problem now assumed even more importance.

With Mr. Wilford and six advanced students of the University of Minnesota, I was at the site from June 18 to 24. While further working out the interesting geological stratification at the site, we were on the lookout for any evidence of ancient man at the place. None whatever was discovered. We found no other "flints." There was no evidence of any kind of artifacts. Neither were used objects discovered, such as hearthstones, crude hammer stones, or flint flakes slightly modified by use. There were no flint chips and no broken rejected pebbles, such as are found in all major Minnesota archeological diggings. There was no evidence of camp fires. Not a single piece of food refuse was discovered, whereas at habitation sites and in mound dirt in Minnesota animal bones typically broken in food preparation, but unconsumed, are common. We found no evidence of burial pits. Archeologically, nothing looked as if the find was due to habitation, mound, cache, burial, spring site, trail, or place of rendezvous. There were too many artifacts to be considered typical of the frequent isolated surface finds. What other explanation was there which seemed to fit the facts?



Photos by P. Dittis, Anthropological Lab., Univ. of Minn.

Obsidian artifacts "discovered" at the Biwabik site in late December, 1936; believed to have come originally from Oregon. About 2/3 size

During our days at the site I talked with all the WPA workmen, purchased a number of the artifacts which they had found in December at the pit and along the roadway where gravel had been dumped, and followed up rumors which came to me. As a result of our research we quit work at the site at noon June 24, with the assurance of a problem solved, though this time solved negatively.

The story is a naïve one. It came to me directly from the wife of Mr. Mike Brennan who, in December, 1935, worked at the gravel pit. Mr. Brennan had lived some time in Oregon and was there an employee of the Weyerhauser lumber interests. In Oregon he had picked up numerous obsidian artifacts and brought several of them back to Biwabik during a period of lumber inactivity. In December word came from Oregon that Weyerhauser work was available. So Mr. Brennan got his trunk down preparatory to packing it for his trip westward. In it were the obsidian artifacts from Oregon. What was he to do with them? Here entered a bit of ethnic psychology!! Mr. Brennan's quick Irish imagination saw a joke in the offing. He and his wife's brother, Gust Steckman, also a worker on the gravel project, hid the artifacts in several places at the pit for their fellow workers to find. All plantings were in the sand and gravel close beneath the clay. They could not be elsewhere, since the crew was loading only sand and gravel loosened by blasting.

Mr. Brennan was among the fortunate finders, workmen telling me that he found at least one of the artifacts, gloated over its discovery, and put it safely away in his pocket. Gust Steckman also found one and gave it to Clifford Goldsworthy, a fellow worker, from whom I obtained it.

Within a few days following the find Mr. Brennan returned to Oregon. His brother-in-law has also gone there to work, so I have not consulted either of the men said to have done the actual planting. However, I have no doubt the "flints" were planted substantially as here recorded. I quote from my note book of June 24, written shortly after consulting Mrs. Brennan.

"Today I saw Mrs. Mike Brennan in Washington School building, Biwabik, Minnesota, where she cooks lunch for the neighborhood children attending a Nursery School in said building.

"She told me she was very glad I came to her, because she wished to tell someone about the plant her husband had made as a joke on his fellow workers at the gravel pit.

"She said she had no idea the matter would go so far and of course had no idea it would be considered of scientific importance."

In an effort to allay further disturbance by Indian ghosts of the past, Mrs. Brennan's signed statement regarding the plant by her husband follows:

Biwabik, Minnesota
June 26, 1936

"This is to say that I know personally my husband, Mike Brennan, put the obsidian 'flints' into the gravel near the common corner to Sections 27, 28, 33, and 34, 58-16 at Eshquaguma Lake, St. Louis county.

"It was done solely as a practical joke on Mike's fellow WPA workers at the gravel pit.

(Signed) Mrs. Mike Brennan"

To the June article the Editor of Scientific American appended this note: "Only time and detailed investigation will permit the exact significance of the finds described above to be assessed." Evidently sufficient time and investigation have followed the find to warrant the conclusion that the artifacts are of Oregon origin and were planted at the Biwabik gravel pit as a joke—but not as a vicious joke and with no intent to mislead archeological interests.

FROG FARMING

Frogs living in ideal surroundings

TO all the other myriad kinds of farming, one must now add bullfrog farming. Raising the deep-voiced bullfrog is rapidly coming to the forefront as an important and sizable industry, especially in the southern states.

To the hundreds of frog hunters scattered throughout the South, the full-throated bass voice of the leather-lunged bullfrog always conjured up visions of delicious frog legs frying in hot butter. But now the sound of the nocturnal singers' mellow call opens up visions of profits to be easily made, and the spear, the rifle, and the light have given way to strings of ponds, with lily pads galore and a bullfrog with a tremendous area of back legs sitting on every pad.

There seems to be plenty of profit in this comparatively new industry, if properly conducted. Costing but a couple of cents or so to raise each of the creatures to maturity, they are sold to hotels, cafes, restaurants, and clubs in the larger cities for anywhere from one to eight dollars the dozen. And since government surveys* of the frog industry recently brought out the fact that the supply at present rarely equals the demand, there is plenty of reason for the enthusiastic attitudes of the frog farmers.

SO great is the interest being aroused in bullfrog farming that a leading farm magazine not long ago devoted an editorial to the subject, commenting somewhat humorously on the importance of Louisiana's frog industry and the fact that Mussolini, through his agricultural bureau, has imported 40 large frogs from California, instead of Louisiana, to bolster up his own country's waning stock of bullfrogs. The magazine said:

"Casting an omniscient eye over his sunny peninsula not long ago, Premier Mussolini noted with cold disapproval that Italian frogs were spindling, unprolific creatures with little meat on their hams. This, of course, was not as it should be. To win even the casual approbation of Il Duce, one fancies, a frog would have to have the heart of a lion and a chassis at least as broad as a dinner plate. Certainly it would have to sing bass.

"At any rate, it was the premier's will that his country should become, at all costs, nationally self-sufficient in frog legs. Promptly, upon executive order, a couple of tubsful of selected breeding stock were brought to Mediterranean shores—from California!

"Louisiana folks, of course, will see in this the villainous work of the Los Angeles Chamber of Commerce, or perhaps the sly hand of Mark Twain. Is it possible that Il Duce swallowed whole Mark's mischievous tale of that celebrated California amphibian, the jumping frog of Calaveras County? Has no one told the Italian premier about the incredible wheel base of Louisiana frogs—frogs whose hindquarters have to be sliced off in steaks to fit into a frying pan? Has he never heard that there are patriarchal green-backed monsters in the bayou country the thunder of whose voices rattles the windowpanes in dwellings five miles distant? Why, for years it has been a toss-up whether Louisiana's chief state pride was the Mardi Gras festival or the phenomenal size of its croakers."

UNSCRUPULOUS individuals are quick to take advantage of new situations of which little is known. The frog-raising industry has been no exception; breeding stock is being offered at exorbitant prices to gullible would-be "frog magnates," who are baited on with glowing promises of huge profits. The National Better Business Bureau is coping with the situation; careful investigation is urged wherever frog farming is being considered as an investment.—*The Editor.*

In raising bullfrogs, any piece of bottom land, marsh, lagoon, or pond, well shaded and with an abundant growth of aquatic life and vegetation, is suitable. Many farms are enclosed with boards standing upright or with wire, set deep enough to keep out enemies of frogs, among which are snakes, alligators, hawks, rats, cats, and even the larger frogs of the same or other species. Because of the cannibalistic trait of bullfrogs and because disease follows overcrowding, it is necessary to separate the three different sizes—tadpoles, young frogs, and mature frogs.

IN some sections of the South rice fields are used for frog farming operations. Willows and other shade trees are planted along the banks and the water is never permitted to get any deeper in the areas than is necessary to protect frogs and tadpoles from excessive heat in summer and from freezing temperatures in winter. The depth usually runs from [illegible] to six inches in summer. This [illegible] a good average depth for nat[illegible] frog foods to thrive in. Of course, [illegible] are parts of the frog pond in which deeper water is found, due to natural depressions.

The problem of supplying food to frogs after they had reached the adult stage was, for a long time, the main drawback to successful commercial frog

Skinning frogs

*"Frog Culture and the Frog Industry," Department of Commerce, Bureau of Fisheries.

Natural Supply Rarely Equals Demand . . . Italy Imports Breeding Stock from California . . . Problems of Feeding . . . Farming Replacing Hunting

By FRANK A. MONTGOMERY, Jr.

A large bullfrog of the type grown commercially on many frog farms

farming. This problem was due to the fact that frogs, after they leave the tadpole stage (during which period they will eagerly eat any sort of soft vegetable or animal matter), absolutely refuse to eat anything but live food, or food that moves. As soon as legs develop, bullfrogs leave the water and perch on lily pads or on a shady bank, where they immediately begin an intensive search for small insects and the like. As they increase in size they snap at increasingly larger forms of animal life, until in full adult size, they do not hesitate to take a 3-inch fish or a young turtle or terrapin.

THE Japanese, who have for many years engaged in intensive frog farming, solved the problem of feeding the adult frogs in a simple manner, and their methods have, to some small extent, been introduced into frog farming operations in the United States. The pupae of the silk worm is the food utilized in the feeding operations devised by the Japanese; they are placed in long, shallow, wooden trays containing about half an inch of water and anchored close to shore. There the trays are kept in a sort of rolling motion, and as long as this motion is continued the frogs greedily devour the grubs.

Strong lights along the shores of the rearing ponds are also used on frog farms for attracting insects, especially in the early part of the night. Large incandescent lamps attract many June beetles and medium-sized moths, food greatly relished by bullfrogs. Arc lights attract even larger insects, and as they circle the powerful lights they become exhausted and drop to the frogs waiting below. In another method of obtaining live food for the bullfrogs, various sorts of flowers are planted along the borders of the ponds to attract insects.

Up until the past few years, during which time it was determined that bullfrogs really could be grown successfully on a commercial scale, almost the entire supply for the United States was furnished by frog hunters who hunted their quarry at night. These hunters spotted their prey with lights, and either shot the bullfrogs with small rifles or speared them with small gigs. At one time there were reported to be over 3000 of these hunters who placed on the market close to one million pounds of bullfrogs annually.

THERE are still hundreds of these commercial frog hunters scattered about the country, and they still produce a goodly portion of the country's supply of frog legs. But due to the uncertainty of the wild supply, it is said that the trade is showing an increasing preference for the bullfrogs produced on farms.

According to food experts frog legs compare favorably with beef, chicken, veal and fish, in food value, although not quite as high in protein content. A characteristic of frog meat is that it has very little fat or carbohydrates, which is credited with the source of its delicious flavor. But the greatest appeal which this sort of meat makes is due to its delicacy and palatability, which places the dish in the front rank of epicurean luxuries.

By-products of frog farming hold interesting possibilities. In France and Japan they yield a good return to frog raisers. In these countries the skins are made into glue, one large skin producing three ounces of the finest glue, which is said to be especially good for mending crockery and the like. The skins are also utilized as leather for binding small books, lining purses, and for similar uses.

Capturing frogs for market, on a modern frog farm

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER
Chemical Engineer

How Do You Read?

FOR a better understanding of reading problems and for improving visual efficiency in reading, the Ophthalm-O-Graph and Metron-O-Scope have been developed. The Ophthalm-O-Graph is a portable camera which photographs and records eye movements while reading. The Metron-O-Scope is an automatic and extremely flexible instrument for correcting inefficiency in reading and establishing efficient reading habits.

The Ophthalm-O-Graph in use

In order to secure a photograph of the eye movement with the Ophthalm-O-Graph, tiny lights are focused on the eyes and reflected from the corneas. The reflections, magnified more than four times, are readily seen in the camera view-finder. These pencils of light move with every movement of the eyes. Turning a switch starts the film moving, and while the subject reads a card placed on the instrument, a permanent record of the eye behavior is secured in a few moments. Standard 35-millimeter film is used. The findings of the Ophthalm-O-Graphic records can be used advantageously in conjunction with the usual reading tests. The film shows how effectively the reader attacks the lines of print and a set of questions checks his comprehension. If the eye movements are not in rhythmic manner from left to right, but are jerky and backward, these conditions are recorded on the film and can easily be diagnosed; so can faulty co-ordination between the two eyes.

An accompanying illustration shows photographs of typical eye movements of school children. Instead of making the steady yearly improvement which these records show to be desirable, many pupils do not advance without special help. It is not unusual to find college students still using the amateurish reading technique they used in the third or fourth grades. The eye-movement photograph points out the fault and in many instances indicates the necessary steps for improvement.

The Metron-O-Scope is used for both teaching and remedial measures in reading. In operation, it presents words or phrases in a rhythmical progression from left to right across a horizontal line, and the subject is thus encouraged to perceive larger thought units with each fixation and to make his fixations in the smooth effective manner of the efficient reader.

In actual practice, the instructor sets the instrument at the desired speed, inserts the selected roll of printed material, and starts the motor. After the class has finished reading the selection, a series of questions appears for discussion and complete check on comprehension.

Instructors in several prominent educational institutions have found this technique very satisfactory and say that it answers many reading problems.

Photographs of eye movements made with the Ophthalm-O-Graph

WORLD'S LONGEST

FROM the Texas Panhandle to the plants and homes of Detroit, the world's longest gas line has just been completed to supply southern gas to the northern city. The line is 1580 miles long.

Liquefied Gases as Fuel

BUTANE, propane, and pentane, recovered as liquids from natural gas by compressing them, are rapidly becoming important fuels for both industrial and domestic use. In the liquid form these hydrocarbons can be shipped to points of use under pressure. When the pressure is released they boil at the temperature of the

atmosphere and may be used for fuel in the same way as other gases. In 1935, 76,855,000 gallons of these gases were used as fuel, 62.3 percent being consumed by industries. Their widespread use is indicated by the fact that 29,516 consumers in 163 communities in 29 states were supplied with such fuel by 68 companies.—*D. H. K.*

CYCLOTRON

TWO more cyclotrons have been ordered from a noted steel company, one for the Franklin Institute and the other for the University of Chicago. Important research is expected to be accomplished by this new scientific tool developed by Professor Ernest O. Lawrence.

Shocking Elm Borers

ELM borers infesting the trees of Victor H. Schmidt, of Kansas City, were dislodged in a manner literally quite shocking, reports *Science Service*. Mr. Schmidt, weary of digging them out one by one with a pocket-knife, drove in a couple of nails a few inches apart, attached wires, and "turned on the juice" from a small magneto he had rigged up for his children to play with, and which they had previously been using to get angleworms out of the ground. Out came the borers in a very few seconds. Subsequent digging with the knife showed that the electric method had forced a 100 percent evacuation of their dugouts.

In a report to the weekly journal, *Science*, Mr. Schmidt suggests that perhaps a more powerful current might be used to advantage by nurserymen and orchardists.

America's First Patent

THE first patent ever issued in America was granted in the Colony of the Massachusetts Bay in New England to Samuel Winslow for a chemical process, the manufacture of salt, on the second day of April, 1641. The wording of the patent shown in the accompanying illustration is as follows:

"A GENERALL COURT OF ELECTIONS, HELD AT BOSTON THE 2th, 4th Mo., 1641.

Whereas Samu: Winslow hath made a pposition to this Court to furnish the countrey wth salt at more easy rates than otherwise can bee had, & to make it by a meanes, & way, wch hitherto hath not bene discovred. It is therefore ordered, that if the said Samu: shall wthin the space of one yeare, set upon the said worke, hee shall enjoy the same, to him & his assosiats, for the space of 10 yeares, so as it shall not bee lawfull to any other pson to make salt after the same way during the said years; pvided, nevrthelesse, that it shall bee lawfull for any pson to bring in any salt, or to make salt after any othr way dureing the said tearme./."—*D. H. K.*

Growth of Yeast

UNDER ideal conditions at 30 degrees, Centigrade, yeast will double its weight every two hours. This means that a pound of yeast started to grow at 8 o'clock on a Monday morning would by 6:30 A.M. on the following Monday have grown to a weight equal to that of the earth (6×10^{21} tons). Before entering the yeast business on the basis of these figures it is worth while to consider that the yeast would have consumed many times its own weight in food during the week of growth.—*D. H. K.*

For Safe Driving

A NEW defroster fan to clear the automobile windshield of ice and sleet, steam and dust is driven by a vacuum motor

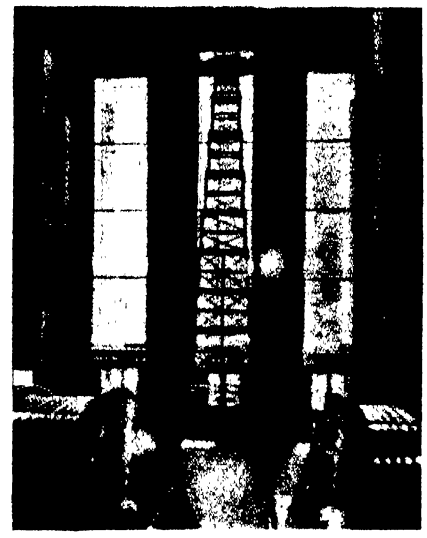
Fan-type windshield defroster

operated from the intake manifold. Operation of this device does not, therefore, drain the battery.

This new defroster, built by the Babcock and Bishop Manufacturing Company, may be installed on any car. The entire unit (see illustration) is in a modern Bakelite case.

Up and At 'Em

LIKE the enthusiast who built a boat in his basement and had to knock a hole in the side of the house to get it out, Rockefeller Center had to devise a means whereby The Great Hall in the International Building, with its 56-foot high ceilings, could be kept clean.



Nine telescoping aluminum frames for reaching 56-foot high ceilings

Setting to work, Rockefeller Center architects and engineers, plus the Economy Engineering Company, evolved the world's highest telescopic tower for cleaning purposes and it is believed to be the first made of aluminum. Consisting of nine concentric telescoping frames rising out of the base, the tower rises 49 feet. The base itself is less than seven feet high to permit its being moved through the doorways. The electric motors can hoist 500 pounds to top height in four minutes and nine seconds.

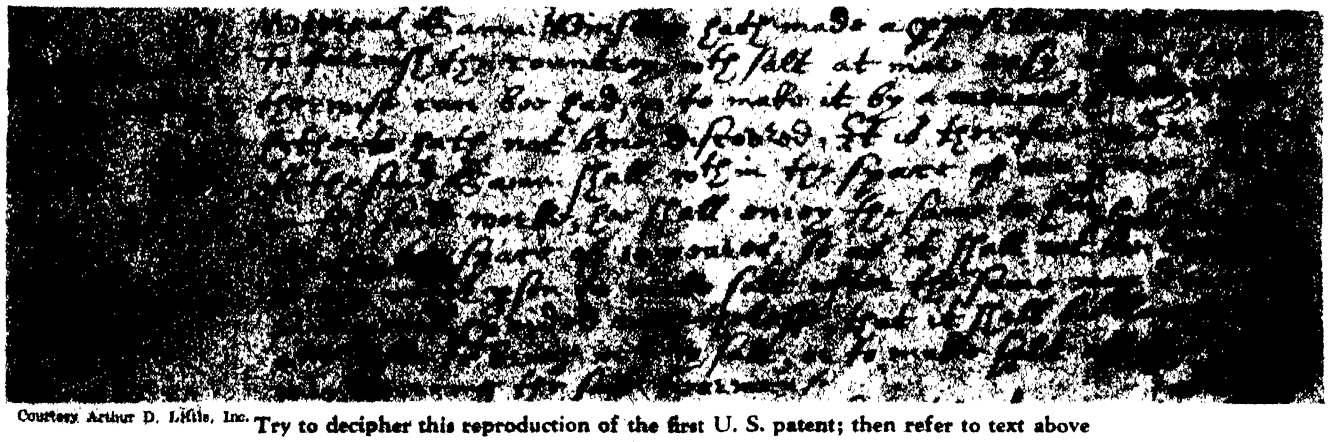
This modern electric jack-in-the-box weighs 3900 pounds, which includes 1400 pounds of aluminum.

Ozone is Poisonous

CHEMISTRY is shattering the popular fallacy that ozone is a bounteous source of human health and vigor. Ozone is confined chiefly to the stratosphere, has proved ineffective against tuberculosis, and were it not for excessive costs and instability it could be used as a war gas, scientists find. It is now believed to have no place in air conditioning.

The latest investigations in this field were reported to the ninety-second meeting of the American Chemical Society by Prof. H. B. McDonnell of the University of Maryland. In Prof. McDonnell's experiments, low concentrations of ozone shortened the lives of guinea pigs. Even those which had been inoculated with tuberculosis died sooner than they would have otherwise.

Ozone, according to Prof. McDonnell, is extremely poisonous when inhaled in higher concentrations. "It is a violent irritant



Courtesy Arthur D. Little, Inc. **Try to decipher this reproduction of the first U. S. patent; then refer to text above**

of the mucous membranes and reacts chemically with the mucous forming a thick froth which, when using the higher concentrations, stops the air supply to the lungs almost completely in a minute or two. There is no indication that the ozone is absorbed and acts as a systemic poison. In lower concentrations the result is pneumonia and bronchitis which may or may not result fatally.

"It is impossible, of course, to say just how much a lethal dose of ozone is. Certainly 0.1 milligram per liter of air is highly dangerous if inhaled for as long as one hour. For daily routine a concentration of one part per million, by weight, is undesirable, and probably dangerous. One-tenth of this amount would, probably, be harmless.

"Ozone has been suggested as a war gas and its high toxicity and specific gravity are in its favor for such use. However, the great difficulty and expense of preparing it in pure condition and its instability, making it impossible to store it under pressure, at once rule it out for such purpose."

Flame Sculpture

CHARACTERS from the famous "The Wizard of Oz" books, "The Arabian Nights," and the legend of St. George and the Dragon have been sculptured in metal by means of the oxy-acetylene process. The Pumpkin Man with a hollow head and wearing a swallowtail coat, the Patchwork Girl dressed in a patched dress and pantalets, the Scarecrow Man with a straw hat, and the Castle of Oz have been fashioned in metal by means of the flame. The dragon that St. George fought rears its ugly head once again and bares wicked fangs of steel while its scaly serpent's body writhes in ensnaring coils. Dancing girls and houris garbed in gossamer metal costumes entertain a metallic Satan while butterflies flit about among steel tamarack trees. Thus do the artistic abilities of one skilful welding operator, L. E. Haybarker, Coeur d'Alene, Idaho, find expression.

Some of the accompanying illustrations of the completed work scarcely show the infinite pains that went into the fashioning of these interesting figures and models.

The vases and trees were fabricated from various pieces of pipe cut to the desired

length by the cutting flame. In order to produce the bark on the metal trees the cutting flame was again used to cut away the indentations and the welding blowpipe to build up the bark and develop the final effects. The butterflies and flowers were formed from sheet metal and all carefully painted in natural colors when completed. Similarly were the dancing girls shaped and built up to completion.

The mummy face seen on one of the vases was executed by first making a mold of fire clay. Over this, steel welding rod was carefully applied until the shape of the head was complete and then finished off by skilful manipulation of the welding flame. Finally it was welded to the vase.

The figures from "The Wizard of Oz" books were built up by free-hand work entirely. To complete the details of this work sheet metal was used to make the dresses and collars.

Different sizes of pipe were used in fabricating the dragon. The largest pipe used was 2-in. As the body becomes less in size other smaller pieces of pipe were utilized by progressively splitting the pipe sections.—*Oxy-Acetylene Tips.*

WETNESS

ONE of the world's wettest spots is the top of Mt. Waialeale, in the middle of the island of Kaui, Hawaii, where the average annual rainfall piles up to 451 inches. Some years it totals as much as 600 inches.

Classifying Coal

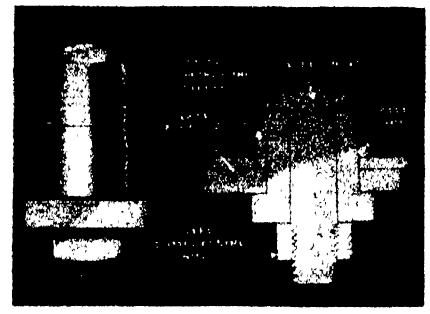
ACCURATE classification of coal from soft lignite through bituminous to anthracite has been accomplished by measuring its oxygen absorption. A new method of test depending upon the action of boiling potassium permanganate solution on a sample of coal allows coals from different sources to be compared more accurately than has been possible in the past.—*D. H. K.*

One-Side Rivet

A MECHANICAL, all steel rivet that is inserted and operated with a wrench, from only one side of the job, gives the strength of a regular bolt or rivet. Riveting jobs that are not accessible from both sides can now be accomplished with this new rivet, by inserting it and drawing down on the nut, to form a solid steel rivet head on the inside.

The steel mechanical rivet is made of a one piece steel body consisting of a heavy steel cylinder with a square head at one end. The other end has a taper valve seat, which sets in a steel expansion and compressing ferrule. A steel bolt goes through the center with its head under the steel compressing ferrule, and the nut at the other end compresses and expands the steel ferrule when turned down.

Examples of sculpture with an oxy-acetylene torch. *Upper left:* Flowers and butterflies from sheet metal. *Above:* Scenes from "The Wizard of Oz" books. *Right:* St. George's dragon rears its welded steel head. *Courtesy of* Oxy-Acetylene Tips



A new steel rivet that can be placed and set from one side of a job

The product is used for riveting steel girders, sheet metal of all kinds, machinery, boiler seams, metal castings, plates on metal containers, pipes and various manufactured products, and is of importance to steel construction, railroads, steamship lines, tunnel construction, outdoor sign companies, and so on. They are used for maintenance work to fasten plates on cracks or holes in fire boxes as they are not affected by heat or pressure; also for replacing loose rivets.

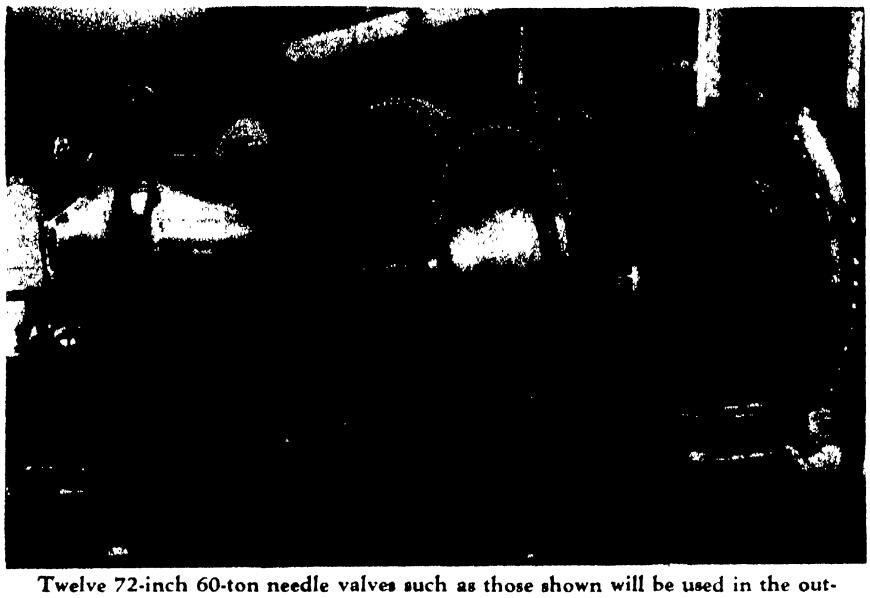
Air Streams Gone Wrong

THE heavenly set-up during the past summer has been all wrong for adequate rainfall between the Rocky and Appalachian Mountains, according to C. L. Mitchell, forecaster for the Washington, D. C., district of the Weather Bureau. From the first of June till the latter part of July the air streams that make weather persistently followed abnormal paths. Unchecked by polar air, a great current of tropical air went 'round and 'round in a vast irregular circle—up the western part of the Great Plains and the Rocky Mountain and plateau regions, across southern Canada, down the eastern part of the central valley region, and back across the continent.

There was no lack of moisture aloft, Mr. Mitchell says, but the machinery for squeezing it out was lacking. Nature produces rain by bringing together two air masses—a cold mass and a warm, moist mass. When the two opposing masses meet, the warm air is forced up over the cold, denser air. The warm air is soon cooled to a point at which it can no longer hold all its moisture.

To keep the United States cool and moist, cold air masses ("highs") must either come down from Canada or they must come in from the north Pacific Ocean. This year the "highs" have been in the south and the "lows" in the north—a situation that makes normal summer weather impossible.

Mr. Mitchell ascribes the summer's unusually high temperatures, in large part at least, to the failure of "highs" from the



Twelve 72-inch 60-ton needle valves such as those shown will be used in the outlet works at Boulder Dam to regulate the amount of water by-passed from the Dam to the Colorado River. When open, 25,000 gallons of water will pass through each valve per minute, at a velocity of 80 miles an hour. The needle in the foreground fits into a nozzle similar to the one shown in the background

north Pacific to move often enough inland over Washington and Oregon and thence eastward over Montana, Wyoming, and the Dakotas. These polar air masses from the Pacific effectually interrupt the northward movement of tropical air over the western half of the United States, and, if they occur at least once every six days, prevent the development of a heat wave over northern areas west of the Mississippi River.

Percheron Pullman

MANKIND'S nobility has always traveled in deluxe transportation, but it took the ingenuity of the National Breweries Limited, of Montreal, to introduce the first streamlined "Pullman of the Highways" motor van to transport its 32 thoroughbred percheron horses, used for exhibition purposes, to and from fairs and expositions in every part of the Dominion of Canada.

Count Alexis de Sakhnoffsky, six times winner of the Monte Carlo Elegance Contest Grand Prix, a prize awarded for designing the most beautiful motor cars for the nobility of Europe, is the man who styled the new van, the chassis of which was built by The White Company Limited, of Montreal.

The van accommodates four horses, each in a separate stall so arranged that all the horses face the front, four men to care for them, and two drivers, a weight in all of nearly 10,000 pounds. Known as the Dawes Black Horse Pullman, it is built on the tractor trailer system. The trailer is specially slung for easy riding with the least possible vibration. The entire unit is 39 feet, six inches long.

The Tack Room at the front end of the trailer is spacious enough to provide sleeping quarters for overnight trips for one driver, while the other is on duty, and there is a system of communication between the trailer and the active driver.

The purebred percherons, known throughout Canada as the Dawes Black Horses, are used to advertise Black Horse Ale, brewed by National Breweries Limited. The horses are entered in horse shows, fairs, and expositions in every part of the Dominion and have walked off with many blue ribbons.

New Method for Treating "The Bends"

AN improved method of treating compression illness, or "the bends," which frequently occurs when divers and others who have been working under high atmospheric pressure return to normal atmosphere, was recently described by Louis A. Shaw of the Harvard School of Public Health.

In this disease, nitrogen absorbed in the blood from the air pumped down to a diver forms bubbles in the blood if the diver rises to the surface too fast. If these bubbles are not dissipated they will stop the blood circulation. For this reason the diver is usually returned slowly to the surface and to atmospheric pressure. Sometimes, however, in spite of this preventive measure, symptoms of the disease appear several hours after the worker has been decompressed or returned to normal conditions.

Recompression, or the process of putting the patient back under high pressure, is the method generally used for treating recurrence or late appearance of the bends. Mr. Shaw suggested that instead of this, the patient should be put in an atmosphere of no more than 30 pounds pressure to the square inch, for two to three hours.

Then the pressure is lowered to 20 pounds for an hour and a half during which period the patient breathes pure oxygen instead of air. This method will promote the absorption of the nitrogen bubbles.

Mr. Shaw reported studies on dogs which showed the value of substituting oxygen for ordinary air in treating compression illness.—*Science Service.*

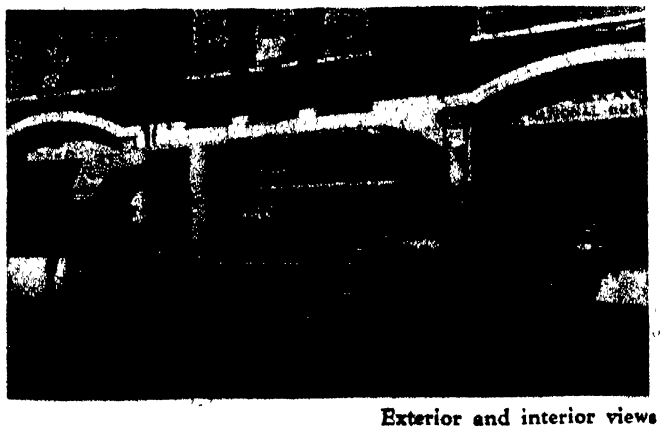
DURABILITY

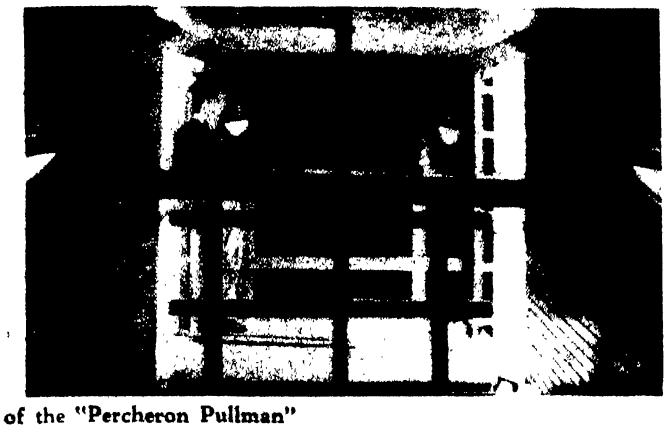
A CARBOLOY-TIPPED drill, just over a half-inch in diameter, in General Electric's Fort Wayne Works, established a combination durability and speed record recently by penetrating approximately 2¼ miles of cast iron at a feed rate of about 10 inches per minute before wearing out. The drill cost was approximately $0.00019 per hole.

"Warmed Up" Ice Better for Vegetable Shipping

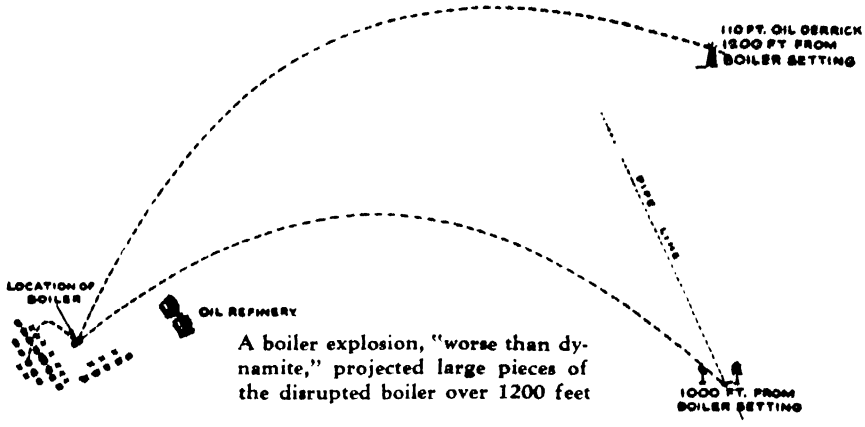
TWO blocks of ice may look alike, but one may be much colder, if from a colder storage room. Ice melts at 32 degrees, Fahrenheit. Below this its temperature follows closely that of the surrounding air.

Failure to let ice of low temperature "warm up" before using it to cover shipments of vegetables may freeze some of them in transit, investigations by the Bureau of Plant Industry, United States Department of Agriculture, show. It found considerable head lettuce and carrots damaged in transit during the warm months last year by crushed ice—generally used now in top-icing lettuce and carrots. The





Exterior and interior views of the "Percheron Pullman"



A boiler explosion, "worse than dynamite," projected large pieces of the disrupted boiler over 1200 feet

ice is crushed in the packing house and immediately blown over the load without much loss of temperature. Chunk top-ice, when used, is placed over the vegetables as they are loaded in the car and has a better chance to warm up to a temperature which does not cause freezing injury.

Freezing damage can be prevented easily by allowing the ice to "warm up" before it is crushed. If there is any doubt about temperature the ice should be allowed to stand until it begins to melt.

Worse than Dynamite

NOW that we are in the internal combustion engine age, and steam boilers are not so plentiful as once they were, many of the present generation have forgotten or never had occasion to learn what tremendous latent forces are pent up inside steam boilers, even small ones. A regular, first-class, all-wool-and-a-yard-wide boiler explosion is something not to be forgotten.

In *The Locomotive*, house organ of the Hartford Steam Boiler Inspection and Insurance Co., a brief description shows what a boiler explosion can do:

"Eight persons were injured and property over a wide area (as shown in the sketch) was damaged when a locomotive type boiler exploded at a Texas oil well location. The accident, clearly a case of over-pressure, tore the boiler into several pieces and resulted in damage to property as far distant as 1200 feet from the boiler setting.

"Surrounding the boiler house were buildings as shown in the sketch. The negro huts and other buildings marked with an 'X' were damaged. One piece of metal passed over a two-story hotel and crashed into a hut behind it, the metal falling in such a way that a negro woman was pinned in bed, but was not seriously injured. Other pieces hurtled over the refinery building, one whole course passing through the top of a large pine tree 1000 feet distant, cutting a six-inch oil pipe buried about two feet underground, and making a deep gash in a second tree. Another piece of the boiler broke off the top of a 110-foot oil derrick which was 1200 feet from the boiler."

Value from Distillery Waste

A NEW method for completely disposing of the waste of distilleries, developed by Buswell and LeBosquet of the Illinois State Water Survey, not only purifies the waste so that it can be safely dumped into streams, but at the same time yields a by-product of gas of high fuel value which pays for the process. The treatment consists of anærobic fermentation (without air) by bacteria which produce from each pound of solids in the waste 11 cubic feet of gas containing a high percentage of methane; this is followed by further fermentation and purification on an open trickling filter. The first fermentation takes place in closed tanks which are kept warm (130 degrees, Fahrenheit) and all odorous compounds formed are burned with the fuel gas. The fermentation on the trickling filter (an open vessel with a false bottom on which rests blast furnace slag in broken pieces) has little or no odor, and thus the objectionable smell usually accompanying such operations is completely avoided. The waste is fed to the fermenters without dilution to secure high efficiency in this part of the process and for similar reasons the effluent from the fermenters is diluted with already filtered and purified liquid before being run onto the trickling filter. After this double treatment the waste can be dumped into streams without harm.—*D. H. K.*

GLYCERINE

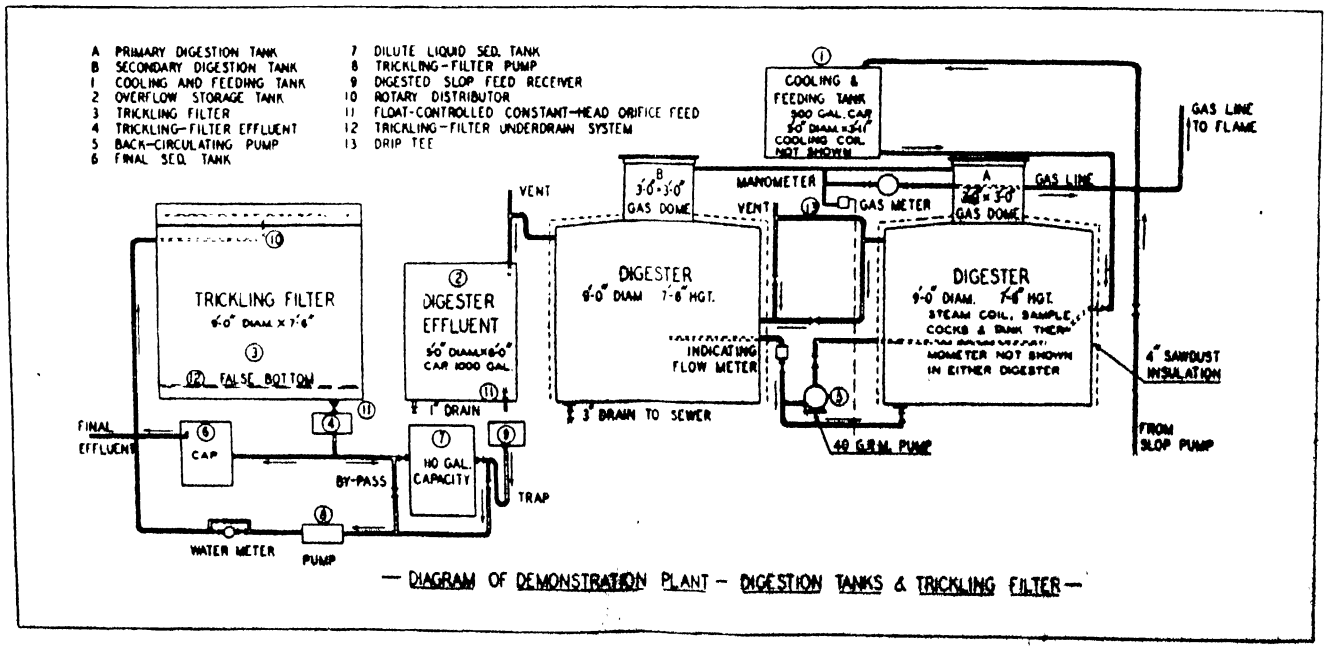
NEXT to water, glycerine is the most extensively used of all liquids in medicines. It stands far ahead of alcohol.

Ornithological Parasite

"PARASITE" is the designation applied to Iowa's ringneck pheasant hens by Dr. Logan Bennett of the United States Biological Survey stationed at the University of Iowa. As the result of recent studies of duck nesting in Iowa, Dr. Bennett has found that this exotic game bird is "ducking" her maternal duties by laying her eggs in the nests of neighboring ducks, according to a recent note from the American Wildlife Institute, Washington, D. C. Four and seven tenths percent of the duck nests studied by Dr. Bennett were so parasitized by pheasants and in a number of cases several pheasant eggs were found in one duck nest.

Ordinarily a parasite is considered as something to be treated with pyrethrum, oil, Black Leaf 40, or perhaps a fine tooth comb. Not so this parasite, however. One must broaden his interpretation of the term to get the proper meaning. The habit of "horning in" on the maternal instincts of the ducks makes the frivolous hen "Chink" a parasite in a social sense.

But the Iowa pheasant should use more discretion in the matter of selecting a substitute mother for her offspring. Race



— DIAGRAM OF DEMONSTRATION PLANT — DIGESTION TANKS & TRICKLING FILTER —

For MEN *who want to become independent in the* NEXT TEN YEARS

IN the Fall of 1946 two business men will be sitting in a down-town restaurant. "I wonder what's going to happen next year," one of them will say. "Business is fine now—but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh.

"That's just what they said back in 1936," he will answer. "Remember? People were looking ahead apprehensively—and see what happened! Since then there has been the greatest growth in our history—more business done, more fortunes made, than ever before. They've certainly been good years for *me*."

He will lean back in his chair with the easy confidence and poise that are the hallmark of real prosperity.

The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say.

● Today the interview quoted above is purely imaginary. But be assured of this—it will come true. Right now, at this very hour, the business men of the United States and Canada are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say:

"I've got what I wanted."

And the other will answer:

"I wish I had those years back."

In which class are you putting yourself? The real difference between the two classes is this — one class of men hope vaguely to be independent *sometime;* the other class have convinced themselves that they can do it within the next few years. Do you believe this? Do you care enough about independence to give us a chance to prove it? Will you invest one single evening in reading a book that has put 400,000 men on the road to more rapid progress?

This book costs you nothing — and for a good reason. It is worth only what you make it worth. It explains how for more than twenty-five years it has been the privilege of the Alexander Hamilton Institute to help men shorten the path to success; to increase their earning power; to make them masters of the larger opportunities in business.

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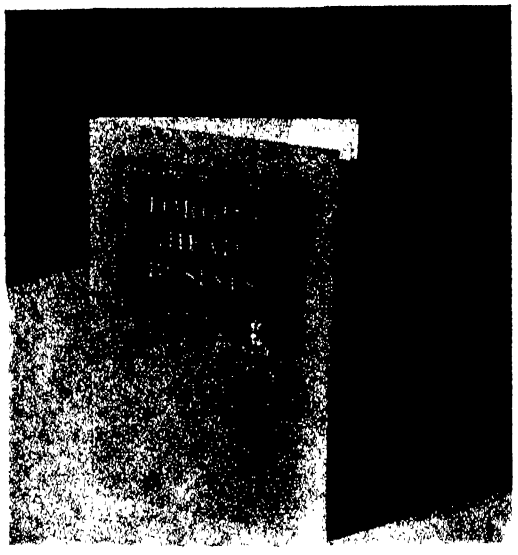

"FORGING AHEAD IN BUSINESS" is an interesting, helpful book. It is yours for the asking. Send for it. Measure yourself by it. Look clearly, for a few moments, into *your* next few years. Whether or not you will follow the path it points is a matter that you alone must decide.

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*Business Position*_____

suicide might seemingly be the result of her present heedlessness in this respect. For Dr. Bennett tells us that the pheasant chicks follow their foster mother and her legitimate ducklings to water, and being unable to swim, they quickly drown in this unusual element. But while the duck is certainly an ill-suited mother for pheasants, there is apparently little likelihood of race suicide from this cause as natural checks and balances prevent such a disaster.

Varicose Ulcers

A NEW method of treating varicose ulcers which appears more satisfactory than any treatment hitherto suggested is described in the *Journal of the American Medical Association.*

Twenty-six persons have been treated by the new method for this chronic condition after from one to 37 years of suffering during which time all recognized forms of treatment had been tried on one or more of them. All except three were healed after treatments extending over periods of from one to 12 weeks.

Dr. Leslie Saylor of Topeka, Kansas, and Drs. Joseph Kovacs, A. Wilbur Duryee, and Irving Wright, of New York City, make the report, states *Science Service.* Their experimental work was done at the vascular clinic of the New York Post-Graduate Medical School and Hospital of Columbia University, aided by a grant from the Josiah Macy, Jr., Foundation.

During the new treatment none of the patients was put to bed or sent to a hospital. They continued their daily occupations of washing, ironing, cooking, chopping wood, and selling real estate.

In treating the varicose ulcers, the doctors saturate a reinforced asbestos paper with a 0.5 percent solution of acetyl-beta-methylcholine chloride and wrap it around the patient's foot and leg as high as the knee. A metal plate is placed over the wet asbestos paper and connected to the negative pole of a galvanic machine. The current is then turned on.

Half-hour treatments are given two or three times a week. The metal plates are never applied over the ulcerated area.

This form of treatment has especial value, the four physicians assert, in cases in which ulcers do not heal after the injection treatment for varicose veins or in cases in which injections are not to be recommended as, for example, with diabetes or phlebitis.

Scientific Weather Cycles for Concrete

RESEARCH engineers, in comparatively short periods, are successfully duplicating many years of the effects of time and weather on concrete in the laboratories of the Portland Cement Association in Chicago.

Specimens of concrete of various sizes and shapes are taken from tropical warmth to the middle of a hard winter and back again, each 24 hours. Thus far, more than a thousand cycles of freezing and thawing have been completed.

These tests are deemed important because the reaction to severe winters is one of the measures of the durability of a structural material exposed to the weather.

The specimens to be tested are immersed in water containers and placed in a freez-

ing room where it is always 20 degrees below zero. Then they are thawed in a tank where the water is kept at 80 degrees.

After 20 or 30 cycles, the specimens are dried and weighed to determine whether there has been any deterioration or spalling off of the surface. The original weight of each specimen is carefully recorded and periodical weights are determined as long as the tests continue, which may be for years.

New Paint Pigments

SINCE the destruction of paint films has been shown to be largely caused by ultra-violet light, a new type of pigment which is opaque to this destructive radiation is attracting special attention. The compounds of various metals, particularly zinc, lead and titanium, with phthalic anhydride, a coal tar product important in plastics and dyes, have been found particularly opaque both to visible light and to ultra-violet radiations. Henry A. Gardner in describing the new pigments in *Industrial and Engineering Chemistry* states that they should be especially valuable in extending the life of cellulose compounds, used in lacquers and many plastics, by reducing the action of destructive radiation on them. At the same time the new pigments may be useful in lengthening the life of rubber, in increasing the light resistance of viscose films —more familiarly known as Cellophane— and in preventing change of color through fading of colored pigments.—*D. H. K.*

Chance for the Elm

THOUGH Europe may have given up hope of saving its elms from the Dutch elm disease, America need not despair of saving its trees, in the opinion of Lee A. Strong, chief of the Bureau of Entomology and Plant Quarantine.

The American elm's chances for surviving the infection, Strong says, are better than 50-50, if men and facilities are available to continue the intensive eradication campaign by the department now under way.

Strong bases his opinion on the results of this year's scouting. In the first three weeks of June, 1437 scouts found 607 trees in which the disease has been confirmed by laboratory test. In the same period last year, 200 scouts found 443 such trees. With seven times as many scouts in the field, an increase of less than half in the number of diseased trees affords good ground for believing that the campaign will first stop the spread of the Dutch elm disease in this country and finally stamp it out.

The only practical way to fight Dutch elm disease, according to Strong, is to destroy every sickly elm in the areas where the disease occurs.

Reducing Corrosion

NUMEROUS chemical compounds added to water reduce the rate at which it corrodes metals. Among these, the so-called organic amines, chemical compounds similar to ammonia, have been found to be particularly effective even in very small proportions. Professor Charles A. Mann and his co-workers at the University of Minnesota have investigated the reasons for this effectiveness and have found that the electrically charged ions formed by amines in

(*Please turn to page* 301)

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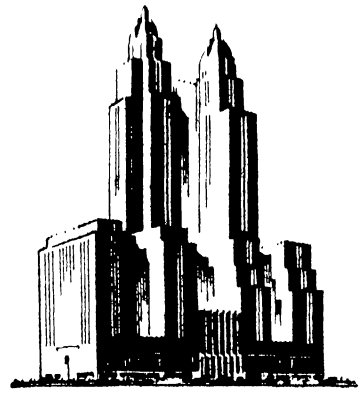

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THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

FIRST, this month, we take a little trip: India, Japan, South Africa, Manchukuo, New Zealand, then home.

Figure 1: India, Calcutta, 28 Gangadhar Babu Lane, Hari Charan Datta. "It was an auspicious day indeed when I chanced upon the advertisement of your book 'Amateur Telescope Making.' The book was a god-

Figure 1: **Datta, India**

send to me. Please accept my sincerest thanks and salaams.

"The mirror was ground from a disk of plate glass ¾" thick and 5.65" in diameter, on a similar glass, using the inverting device of Mr. Porter, as illustrated on page 288. Time consumed, about 18 working hours using Carborundum powders. The mirror was polished on a rosin and beeswax lap. The best proportion, after many trials here at Calcutta at that time (middle of October), was found to be 1 in 20 and the best method of cutting the channels was found to be sawing, as advised by Mr. Pierce. The hack saw blade was kept rubbed on soap. It took me about 40 hours to polish and 10 more to parabolize. I made all the tests, including the Ronchi test, which was done by 8 strands of hair spaced one tenth inch. The total cost of my instrument was about 24 rupees [about $9.—*Ed.*]. My sincerest thanks and salaams for distributing the knowledge by means of which a novice like me on the other side of the globe has made a telescope."

Figure 2: Japan, Yokohama, 140 Mameguchi-dai, R. M. DeMuth. The capstan for turning the head of the tube is interesting. No other data were received.

Figure 3: South Africa, Capetown, Mowbray, Clifton Road, "Tirerevan," W. G. Andrews. "I was able to get 6" disks in Capetown but could not get Carborundum grains till I mentioned it at the Astronomical Society, when I received any amount. It was only after the mirror had been finished that I discovered that I had been using paving asphalt, but had not the slightest trouble with the lap. I had been reading in 'A.T.M.' about the many different figures I might strike but had beginner's luck, as almost the first test was paraboloid; so, to see them, I rubbed several holes in the mirror, and then I did see them! It took several hours to get it parabolized again. The 2¼" finder was salved from a wreck in False Bay. The total cost was under £1."

Figure 4: Manchu-kuo, Harbin, Slavianskaya St., P. Ramensky. "The mirror is of 6" diameter and gives magnifications up to 300 diameters. The mounting is from Ford rear axles."

Figure 5: New Zealand, Auckland, W. 2, Grey Lynn, West End Estate, 161 Garnet Road, Alf. R. Martin. "I enclose a photo of a 12" reflector built by myself. It is mounted on Ford back axle housings. There are quite a number of amateur observers here. Recently, in this city, we have formed a club and meet once a month for discussion."

Home, James.

ABOUT making camera lenses: From time to time since this hobby of amateur optics was got going in 1926, requests for instructions for making camera lenses have been received. A number of years ago we addressed letters to some of the photographic journals, asking for light on this situation and parts of the replies, published below, still make interesting reading; they show that the job surely is not a beginner's

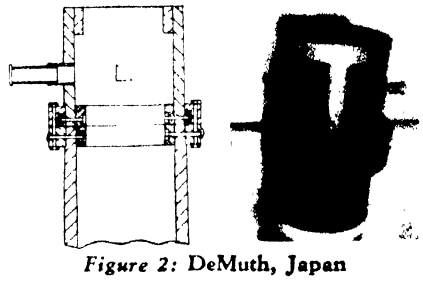

Figure 2: **DeMuth, Japan**

job, also perhaps that the ability of at least some amateurs may have been a bit underrated. It is true, however, that at that time there were few who could be called advanced amateurs, as there are today.

The first letter:

"I am afraid you are up against a tough proposition. The photographic lens is entirely different in conditions from the telescope lens in that it must cover a very wide field at a large opening, say 80 degrees at F/4.5, with minimum errors.

"Photographic lens computation is not easy. Lens designers are only able to compute about one lens per year. Even Dr. Rudolph, one of the most famous, calculates only one in about two years."

The second letter:

"We have not published material of this kind for three reasons: first, the calculations involved are over the heads of the majority of our readers; second, even if the calculations were understood, few, if any, readers would have the necessary grades of optical glass or the mechanical equipment to produce the lenses; and, third, the manufacturers keep their lens calculations a trade secret."

The third letter:

"Personally I am averse to exploiting making things at home which can be bought better made and often at lower cost in the shops. This is not wholly a commercial expedient, either. It is based on two facts—the mass of readers cannot make complex things, and the price of such things is usually lower than the cost of material and waste through spoilage. The optical stores are so generally equipped for grinding lenses and the optometrist is usually a college man trained in computations that the layman could do no better than formulate his needs and have them filled by an expert.

"I gladly tell you that never more than in photographic objectives is the refractive element a factor. Even further, the refraction and diffraction enter into the computation of curvatures. Flare spots and lateral catch of light show on the sensitive emulsions where the eye, looking through a telescope, might not see them or mentally ignore them." [That one sounds snooty.—*Ed.*]

The fourth letter:

"The making of a simple camera lens, such as a meniscus or rapid rectilinear, is not beyond the capacity of an amateur worker. When it comes to the question of making an anastigmat, however, the problem is a difficult one and it would require an excellent machine shop equipment and the making of so many tools that the cost of a single lens would be far above the retail purchase price. The anastigmat consists as a minimum of three elements, but those which would be easiest to construct would have four or six and it would presumably require a grinding shell and a polishing and test block for each surface, and as the utmost accuracy is required in the polishing, even a skilled optician needs much experience to make anastigmats which will pass the necessary tests.

Figure 3: **Andrews, South Africa**

Figure 4: **Ramensky, Manchu-kuo**

"The principal difficulty, however, lies in the fact that, even if the amateur can get optical glass of approximately the proper constants—which he might be able to through the courtesy of one of the few lens manufacturers—the manufacturing optician finds that every batch of glass varies, so that in practice every lens has to be recalculated every time it is made from a new lot of glass. Of course, the optical firms do this rather empirically, and have in their possession data arrived at from many years' experience, which enable them to make these changes without much difficulty.

"We have had under consideration the possibility of publishing a book on lens making and could command the services of one of the best lens makers in the country for the technical details, but we have hardly considered the publication feasible for the reasons set forth above. Telescope making is child's play compared with photographic lens making."

These letters were shown to an amateur telescope maker who both calculates and makes his own camera lenses and he commented: "The first one tells the true story, the attitude shown in the second is justified, the cackle in the third gives me a ——, and the fourth is about right." He added, "Do not trust examples given in patent specifications of lens designs. Impossible glass types are frequently specified and residual aberrations or flare spots are said

Figure 5: **Martin, New Zealand**

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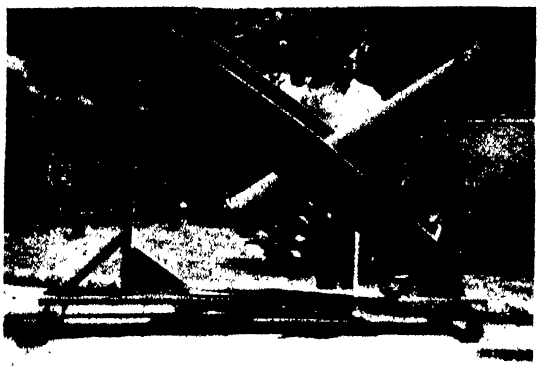

Figure 6: **Hole, Pasadena, Calif.**

to be deliberately introduced as jokers."

Some years later—that is, a year ago—we invited the writer of the above comments to prepare for Vol. II of "A.T.M." a detailed chapter on photographic lens making, for we were still hypnotized by the desirability of making such data available to the amateur and hoped there might be some possible way out. This is his reply:

"I believe it would be impossible to write a chapter on the general subject of photographic lens construction, because the mathematical treatment of comatic, astigmatic, sinical, chromatic, spherical, distortion and flatness errors would occupy an immense amount of space, even if the rudiments and one example only were taken. The absolutely necessary discussion of glass types and the graphic methods of 'bending' compromises would consume more space, as would the discussion of the relative merits of the various corrections for different purposes. And, even if you were to give me 500 pages, quarto, I should have neither the time nor the ability to write such a treatise. You know I'm neither a Frauenhofer, a Rudolph nor a Conrady.

"I can compute for you, however, some examples, giving glass types, radii, thicknesses, separations and iris positions for, say, an *f*/4.5 Tessar, an *f*/4.5 Cooke triplet, an *f*/6.8 Goerz Dagor, an *f*/6.3 Rudolph Protar, or some such popular combination. However, when the amateur had read the dope, he would find that the glasses he could obtain from B. & L., Chance, Schott or Gobain would not have the precise constants called for. Values would be sure to differ by several units in the fourth and possibly in the third place. He would then have to recompute his system for the new values, which would mean that he would need to be quite proficient in the art.

"In a doublet astronomical objective, it is *easy* to work to the 'V' figures of a pair of glasses in order to get fair chromatic correction, and then to figure one surface in order to approximate spherical correction for visual rays, since the axial image is all that matters. In a photographic lens, though, 20 or more compromises must be made, and few errors are completely eliminated, since, in order to cover a large field sharply at a large aperture, on panchromatic plates, relatively minor errors must remain in order that major faults may be eliminated. In order to cover 40° on 35 mm. film at *f* 2.0 apochromatically, within only 0.01 mm. of true sharpness, Lee had to use ten components, two of them unstable in air!"

Well, there we are—where? Nowhere, apparently. Incidentally, the man who wrote that letter is not a professional in any sense; he is a chemist who makes telescopes and so on as a hobby. But he dislikes answering letters and that is why we cannot give his name here—from past experience, he would probably shoot us. In fact, any mention here of any man's name always brings him a big batch of those six-page letters (without even return postage being included!), using up all his spare time and more, if he is kind to all.

We replied to the letter: "Your answer gives me a good laugh: you talk yourself into the proposed writing job and then right out again. But your logic is watertight: to give the background stuff would require a book; some examples might be given; but then, the exact glass not being obtainable in each instance, the amateur would be just where he started. I shall publish this sometime and if the readers who have asked for full instructions for making an anastigmatic lens don't still think I am in the Ananias Club they will stop teasing for them and materially lengthen my life." He replied: "Too bad about the wet blanket I pulled over the photo lens flame, but facts are facts. My own computations have been performed solely to fill some

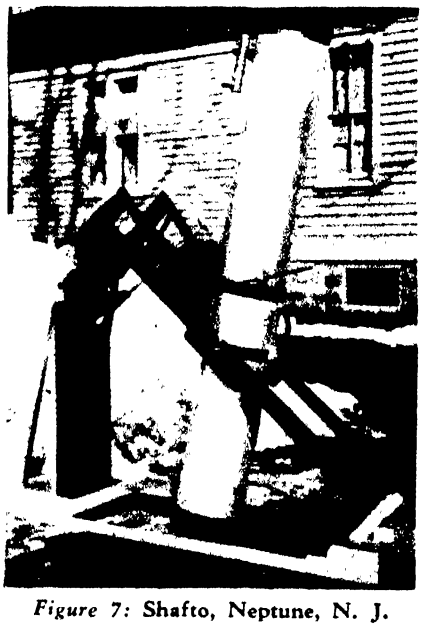

Figure 7: **Shafto, Neptune, N. J.**

personal need. I don't do outside jobs."

The same man also wrote this: "I can't sit down with a couple of reciprocal and log. tables and a glass list and design, say, an anastigmatic magnifier. Each job has meant looking up forgotten equations and eikonels, brushing up on a differential or two, making a dozen graphs to assist in balancing compromises and then beginning algebraic third order work, which must be followed by trig. ray tracing. The tracing takes five to 100 hours and may show higher order faults which make it necessary to recompute some of the system. In other words, I stumble along, consulting Steinheil, Hastings, Gardiner, Conrady and Taylor from time to time. A good computer would be finished when I was half through."

Another amateur who has done much lens designing writes in the same vein: "The stuff you send me [just quoted.—*Ed.*] clicks with what I've always said—that you

can't give 'simple rules for calculation of optical instruments.' They are *invented*, not calculated. Every new item is a new problem. After you've traced rays through 100 or more sets of lenses you learn about what to expect, but you couldn't tell anybody how, any more than you can tell why you like the little red-head on the end better than the blonde in the middle."

Not, however, that all this will stop the requests for "detailed instructions for photographic lens making," since they come mainly not from amateur telescope makers but from outside. But with these various comments now in print, all we shall have to do in future is to tell them which back number to buy. We inserted them here merely to save ourselves future hard work! But even yet we harbor a bull-headed hope that, someday, somehow, someone will find a way to impart the "dope."

WHILE telescope making is not generally a juvenile hobby, a few keen lads have made good telescopes. Wilson Hole, 540 South Greenwood Avenue, Pasadena, California, has arranged a double yoke in "wheelemout" fashion (Figure 6). His use of a deep section for the yoke sides is pleasing to look at and lends steadiness. His carriage has four corner screws—½" bolts—which screw down to give a solid stance, much as a wrecking crane lets down corner screws or a dredge pokes down spuds and ceases merely to float. Hole, a young friend of R. W. Porter's, writes that he has made about five mirrors and completed three telescopes in the past two years. He hopes to join the A.A.V.S.O. His age is 14.

Figure 7 shows a mounting of angle iron, made by Eugene Shafto, 1114 Corlies Ave., Neptune, N. J. The yoke, with split ring, is arranged the same as the one on the 200" telescope at Mt. Palomar. The ring is of hard wood, backed with iron. The maker submits a list of expenditures, which totals $16.75 for the 8" telescope.

A second keen lad who has made good as a telescope builder is George Economy, 108 Auburn St., Manchester, N. H.—see Figure 8. He is 13 and did the job in three weeks, making a model described in earlier editions of "A.T.M." by John M. Pierce. The entire cost, he writes, was $15.

Figure 8: Economy, Manchester

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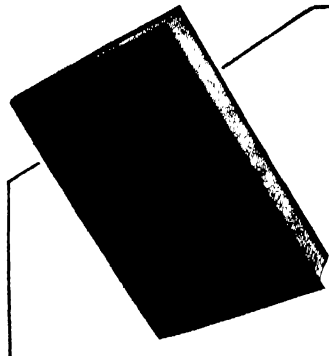

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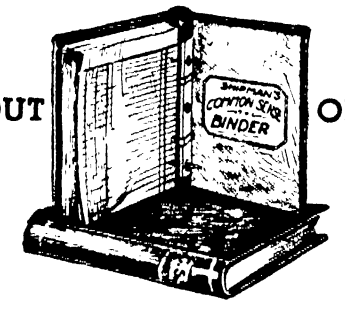
OUT 

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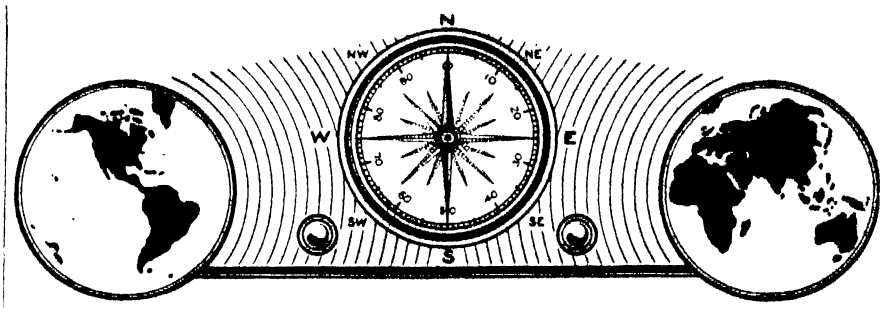

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It is expected that the service will be widely used by various classes of harbor vessels, and possibly by certain vessels operating in Long Island Sound and on the Hudson River.

The Western Electric shore radio equipment installed by the telephone company includes a 400-watt short-wave transmitting station atop the building at 25 Hyatt Street, St. George, Staten Island. This station transmits on a frequency of 2590 kilocycles under the call WOX. Three receiving stations are maintained nearby on the island to insure consistent service. Facilities are provided at the central station for interconnecting the radio voice-waves with the telephone company's regular land wires. The seven boats so far equipped have 5-watt transmitters which operate on a frequency of 2198 kilocycles.

An improved method of calling the boats by means of selective signaling apparatus has been put into use. Under the old system of loudspeaker monitoring, the ship crew had to listen constantly for the ship's particular call. With selective signaling, a regular telephone bell rings on the ship being called, obviating any confusion. The manipulation of the ship telephone is nearly the same as that of an ordinary telephone, thereby making unnecessary the employment of skilled operators on the boats.

These stations can be picked up on any all-wave receiver covering the frequencies of 2198 and 2590 kilocycles. If two receivers are used, one tuned to each frequency, both sides of the conversations can be picked up. No definite operating schedules are maintained; the system is used only when there is traffic to be handled.

Noise Interference Data

SOME interesting figures dealing with the analysis of radio noise complaints received by three large power companies during the past year have been released by Philco. The percentages are of particular interest, as they indicate the degree of probability of the source of noise interference you may be experiencing.

The total number of complaints received was 9334. In 2735 cases noise originated in consumers' electrical equipment, and in 984 such instances the equipment was motor operated. In 563 instances, noise was due to building wiring defects, and in 532 instances due to interrupter devices.

The following percentages indicate the responsibility for the most prevalent forms of noise interference:

Responsibility	*Percentage*
Power Company	23.6
Other Utilities	6.4
Consumers' Equipment	29.3
Radio Sets	13.0
Transient and Not Found	27.7

If you're troubled with noise interference, scout around for defective electric light bulbs, washing and sewing machines, neon signs, oil burners, electric sign flashers, and so on, as the most likely sources. You may find the trouble in your own home.

"Magic Voice" Tone Tubes

A NEW approach to the attainment of naturalness in electrical sound reproduction has been made in the 1937 RCA-Victor "Magic Voice" series of radio receivers. Normal low-frequency response has been gained in these sets without resorting to artificial means of build-up.

The accentuation of bass response, particularly from 100 cycles down, is brought about through the use of built-in phase-reversing resonator tubes. These tubes are

nothing more than a series of cylinders, open at both ends, which project through the bottom of the receiver cabinet. The rear of the cabinet itself is closed in, so that sound waves radiating from the rear of the loudspeaker must seek outlet through the resonator or tone tubes.

Under ordinary circumstances, the sound waves radiated from the rear of a loudspeaker extend into free air and, by means of reflection from the wall of a room, or by direct transmission through the air surrounding the receiver cabinet, reach the front of the loudspeaker. Due to the difference in phase between the front and rear sound radiations from the loudspeaker an interference is set up and certain frequencies are attenuated. The maximum amount of attenuation takes place at the low frequencies with the result that bass response from the loudspeaker is often deficient.

By means of tone tubes or acoustic neutralizers, the air set in motion by the back waves from the loudspeaker is caused to flow from the ends of the tubes in phase with the front waves, so that cancellation no longer occurs. Instead, the back waves reenforce the front waves, with a consequent increase in the efficiency of sound projection. Thus, by providing this simple means of making the back and front sound waves from the loudspeaker additive, the bass response is increased above the normal limits of the loudspeaker.

Netherlands Broadcasts

BECAUSE of its extensive colonial possessions the Netherlands is interested in developing short-wave broadcasting along the lines of imperial broadcasting in Great Britain. The Phohi (Philips Broadcasting Holland-East India) has taken the initiative in this matter and now has four distinct short wavelengths at its disposal. It is proposed to increase the power of one of the transmitters to 60 kilowatts to insure its being heard as well as the stations of other colonial powers.

The transmission of propaganda broadcasts to the United States by these stations to stimulate travel in the Netherlands is now under consideration, the plan being to broadcast three hours a week.

Noise Filters

A NOISE filter is a practical, inexpensive device designed for the purpose of reducing or eliminating certain forms of noise in radio receivers, but a noise filter is no cure-all.

A noise filter will not reduce or eliminate noise which reaches the radio receiver via the antenna. It is not designed to do so. It is of value only in such cases where the noise interference reaches the receiver via the power source—A.C. outlet, D.C. outlet, 32-volt lighting plant, or storage battery operated vibrator power supply.

It is an easy matter to determine if noise enters the receiver through the power line or by way of the antenna. Turn on the receiver and tune to a point between stations. Then disconnect the aerial and ground (or the two leads of the antenna if a doublet is used). If the noise disappears or is greatly reduced, the chances are that the noise is being picked up by the antenna system. On the other hand, if the noise persists, and is not reduced appreciably when the antenna system is disconnected, then it is safe to assume that the noise is being fed to the receiver through the power line. In such an instance, a good noise filter (not the type you can buy from peddlers on street corners) connected between the electric outlet and the receiver power plug will reduce or completely eliminate the disturbance.

If the noise is fed to the receiver via the antenna, a noise-reducing antenna system should be employed. If one is used and the noise still persists, then the horizontal doublet wires should be raised to a higher level, or suspended in a different direction.

Neither the noise-reducing antenna nor the noise filter will reduce interference from natural static.

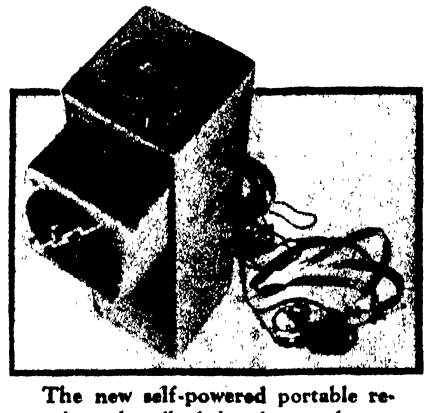
Self-Powered Portable Radio

A SENSITIVE receiver about half the size of a golf bag, weighing only 18 pounds, and operated entirely from dry-cell batteries, is the latest development of the Crosley Radio Corporation.

This new receiver, shown in the accompanying illustration, is truly portable in every respect. The carrying case houses the receiver chassis and the battery compartment. The loudspeaker is attached to the side of the case and is connected to the receiver by means of plugs which may be removed from the jacks on top of the carrying case when it is desired to use headphones.

Because of the high sensitivity of the receiver only one foot of antenna wire is necessary and a ground connection need not be used at all. There are no attachments to be made to exterior points, and if one wishes, the set can be placed into operation and used while walking, or on bus, automobile or train rides. The fact that it is portable and ready for instant use, gives the set a much wider scope of usefulness than the ordinary type of receiver.

By means of the headphones the receiver can be used at, say, a football game without

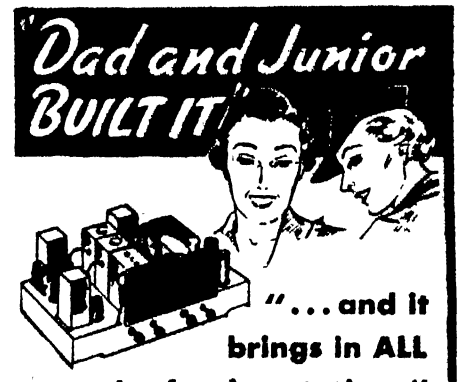


The new self-powered portable receiver described in these columns

disturbing those sitting nearby. It would be possible, then, to watch the game and simultaneously follow the play-by-play broadcast from a local radio station.

The receiver employs six dry-cell type tubes and has a standard airplane-type tuning dial. Since a ballast tube is used to control filament voltage to the receiving tubes, no auxiliary control other than the "on-off" switch is required.

"Dad and Junior BUILT IT"



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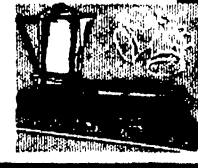

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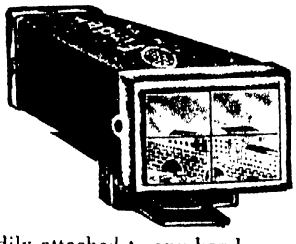

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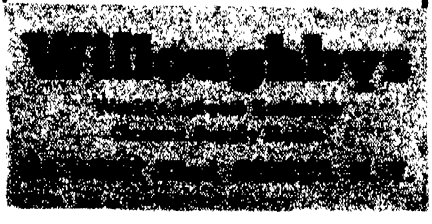


CAMERA ANGLES

Conducted by JACOB DESCHIN

Photographing Domesticity

THE life domestic as a photographic possibility is a veritable gold mine if we will take the trouble to look around. The next time you are obliged to stay indoors for one reason or another, such as bad weather or pure inclination, let your gaze roam leisurely about the little world that you call home. You will be surprised how many camera subjects will take shape before you that you had never suspected; how nooks and corners, made humdrum through long familiarity, how the daily routine, apparently uneventful because of close association and repetition from day to day, suddenly appear new and attractive when observed from the point of view of the camera.

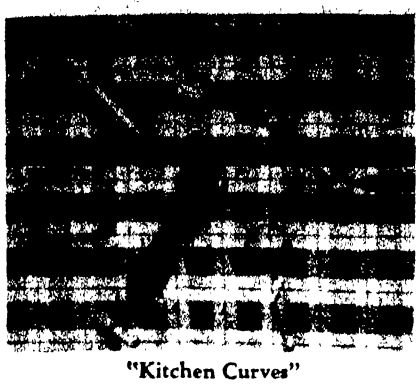
"A Sunny Corner"

You will do best to set your camera on a tripod or other firm support and study your subject carefully. Sometimes you may wish to include a human subject, in which case the latter will be merely a part in the general composition and not the main feature. In most instances, however, you will find the inclusion of human subjects unnecessary—sometimes detrimental, in fact. A view camera will be best, though any camera will do which has a ground glass on which to compose the subject. A camera of the simple bellows type having a direct view finder need not be a handicap if you measure the distance carefully, stop the diaphragm of the lens down sufficiently to get over-all sharpness (where this is desired, as it probably will be in most instances) and, because it will often happen that you are obliged to include more in the picture than you wish, use the enlarging method of printing in order to cut out the extraneous matter and yet get a good sized print.

The most appropriate lighting for this type of camera work is that which you find illuminating the subject when you spot it. Since lighting makes the picture, it is lighting that will reveal the picture possibility to you when you first view it. The light may come from a table or floor lamp or it may be some arresting effect caused by daylight coming directly through a window or reflected from a light-toned wall. Sometimes, as in the case of "Kitchen Curves," you will find it necessary to use strong artificial light carefully directed to obtain a desired result. In this case, the subject called for an even light over the entire area. Two reflectors were therefore used, each containing a single Photoflood bulb, and their position so disposed that the entire area was evenly, or, to use the more technical term, flatly, lighted.

The majority of subjects will be found to be worth while because of the peculiar way in which daylight falls upon them, as in "A Sunny Corner" and "Wash Day." The latter was photographed from the rooftop of an adjoining building, the subject having been found appealing because of the long shadows caused by a late afternoon sun. "A Sunny Corner" seemed to justify an exposure by its simplicity, sense of peace, its coziness and warmth and gener-

"Wash Day"



"Kitchen Curves"

ally by its genuineness. The atmosphere of the corner was found to be aided by the almost total lack of detail in the black part of the picture.

Simplicity is the keynote of the domestic life. The worker who attempts to photograph it sympathetically will soon sense this; he cannot succeed in this work until he does. After he begins to appreciate the pictorial value of familiar things he will find subjects by the dozen where formerly he saw very little.

A Horrible Example

FOR the edification and moral instruction of our readers, we offer this month the example of a photographic novice who made the fatal error of believing that the purchase of an expensive camera immediately makes the owner a good cameraman. Of course, we know this is not so, and it may be that if we asked the Horrible Example if he thought this were so, he would deny it also. But the fact remains that his actions certainly would contradict him severely.

The sad story follows: Induced, as who is not these days, to join the camera clan, the Horrible Example purchased a 15-dollar outfit that seemed for a beginner a fairly good piece of equipment for the ordinary purposes he originally had in mind; namely, pictures of the family, friends, and other run-of-the-mill subjects. His first results showed under-exposed or abnormally over-exposed negatives with the consequence of poor prints and, in some cases, no prints at all. He blamed the camera, of course, instead of himself. On questioning him this department found that he had taken so little trouble to acquaint himself with the fundamentals of photography before attempting to use the camera that he did not even know the difference between an under- and an over-exposed negative, invariably closed his diaphragm down to F:22 because, he said, he wanted to get everything sharp (ignoring, of course, the fact that there had to be enough light available to permit him to do this), and so far misunderstood the meaning of lens speed and shutter speed that, being told that his lens was "speedy" he made an indoor shot under poor lighting conditions at the fastest speed his shutter would permit!

Believing, as we must assume he did, considering his subsequent actions, that the fault was not his but the camera's, he bought another—F:3.5 lens, reflex mirror, and all, for about 40 dollars. Strange as it appeared to him, the pictures still would not "come out" properly. He now turned, a novice of three weeks' standing, to amateur movies, paying about 200 dollars for a 16-mm motion picture camera, a projector, splicer, screen, and so on. He seemed to have a little better luck with this, possibly because of the F:1.9 lens and the advantages of the short-focus lens. Still hankering for a still camera as an adjunct to his movie activities, he purchased an 80-dollar twin-lens reflex camera and the last this department heard of this bewildered young man's camera experiences was that he accidentally dropped it into a fish bowl while trying to take his first picture with it!

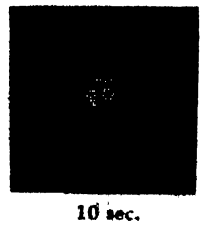
The Horrible Example who has been the subject of this discourse is a family man fully in possession of his faculties, he has money in the bank, and is a respected member of his profession. His case is typical; the reason some do not go the lengths he did is because they do not have the money to do it with. Persons like these should not be discouraged but, when they will listen, given suitable advice so that photography, either as hobby or profession, may maintain the high standards to which it is entitled.

Twin-Lens Reflex

RECENTLY imported, the new Fothflex twin-lens reflex offers camera hobbyists a choice of F:2.5 or F:3.5 lenses, direct focusing on a viewed-from-above ground glass, focal-plane shutter speeds from 2 seconds to 1/500th, built-in delayed action shutter device, automatic exposure counting, and other features in a metal body camera without a bellows. Matched lenses for viewing and photographing permit the user to see the subject up to and during exposure. The camera makes 2¼ by 2¼ inch negatives, 6, 9, or 12 to the roll depending on the type used.

"Stopping" the Moon

WHAT is the longest exposure the moon will stand without showing movement on the negative? This department set out one night at 10 P.M. to find out and here is what it learned: Exposures varied from one second to several minutes. The diaphragm opening was F:4.5 and 35-mm. film was used. Enlargement of the results to about a dozen diameters indicated that an exposure of 30 to 45 seconds could safely be made without showing noticeable movement, though a full minute's exposure did show a definite sign of "doubling" up. The accompanying illustrations show the results of exposures made at 10, 20, and 30 seconds, and one minute. Since many night pictures can be made within less than one minute provided a fast enough lens and



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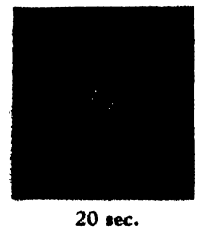

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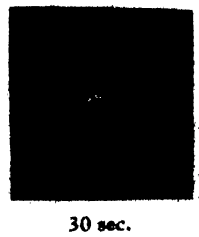

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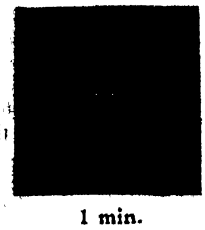

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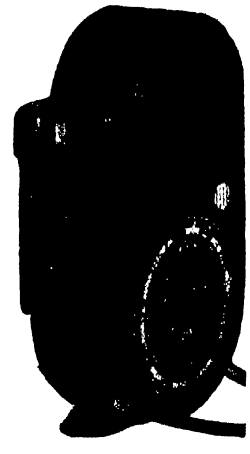

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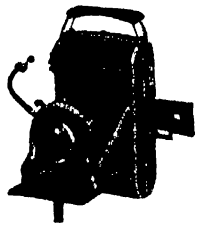

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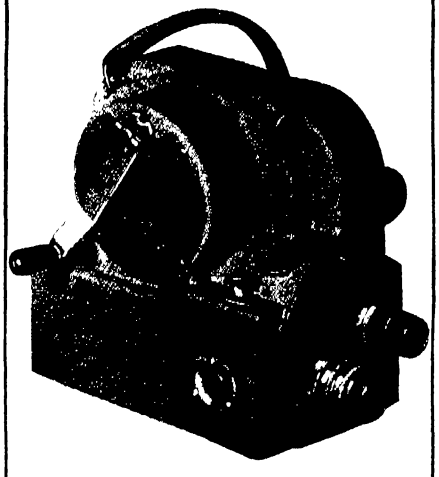

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superpan film is used, it is apparent that the inclusion of the moon when desired is quite within the realm of possibility. Try it sometime.

Loading Bulk Film

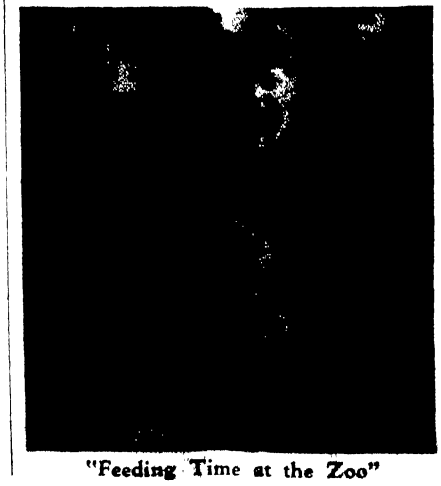
A NOTE of caution to buyers of 35-mm film in bulk: This department has discovered on two occasions that after exposing a roll of film cut from a 25-foot roll, the last two or three negatives were found to have large numbers punched through them. Handling the film by the edges in absolute darkness, as one is obliged to do when loading film on a spool, it is impossible to detect these perforations, and as a result two or three exposures are spoiled. The way to avoid this is to feel along the end of a new bulk roll and cut away a strip the length of the perforated part.

Let the Highlights Fall—

THE old-time photographer's rule to "expose for the shadows and let the highlights fall where they may" was recently observed by a modern photographer in a manner that must have come as a distinct shock to camera-hobbyists. Mr. Steichen was the photographer and his photograph, used in an advertisement, showed a sun-bathing female nude reclining on a white stone staircase. The figure was in good tone throughout but the staircase was so flooded with sunlight that hardly more than a suggestion of the stairs was visible, the rest being "blank paper." Mr. Steichen evidently permitted the "highlights to fall where they may" deliberately in order to bring about the impression of strong sunlight. Mr. Steichen is a photographic genius and whatever he does in his line is worth anybody's attention. His implied lesson here seems to be that when a certain effect is desired "anything goes."

The Child at the Zoo

WHAT would happen to the zoo if there were no children to visit its inhabitants? Certainly it would lose much of its interest, for half the pleasure derived from the zoo by adults is in watching the pleasure it gives the youngsters. The next time you take a child to the zoo don't forget to bring your camera. You may find you have more fun photographing the child enjoying himself, particularly in feeding the exhibits, than in seeing the animals. In



"Feeding Time at the Zoo"

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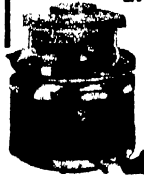

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By Edwin C. Buxbaum, A.R.P.S.

BESIDES having a considerable amount of fun with the miniature camera, making trick "shots," art photographs, and the like, you can also use it for special paying work. This little paper-bound booklet of 72 pages tells not only how to make interesting photographs that are salable to news agencies or magazines but also gives many clues to the very large number of types of photographs that can be sold. For those who wish to mix profit with pleasure this booklet should prove most helpful.—$1.10 postpaid.

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"Feeding Time at the Zoo" the child offering a peanut to the camel has attracted a crowd of both youngsters and adults; the photographer leans well over the railing and takes a shot that proves to be both a good study in concentration and a fine example of human interest photography.

Lunchtime Photography

NOTE your camera with you when next you go out for lunch and avoid regrets over the chance shot you wish you hadn't missed. If you have a camera of the "candid"

"Lunchtime"

type you will probably find it the most useful. The two messengers conversing over their sandwiches while seated at the edge of the fountain is one possibility.

Speedgun Photography

THE varied uses of the Photoflash gun are described in a pamphlet being sent free for the asking by S. Mendelsohn, of New York City. The pamphlet covers the making of portraits, both human and canine, by means of the Photoflash bulb and the speedgun and describes a simple way of making photomontages with the speedgun. The gun may be attached to any camera using a between-the-lens shutter and the accessories available include a remote control device which makes it possible for the "gunner" to shoot his own picture. The Mendelsohn speedgun is the one which has been in use among press cameramen for some years and which has now become available for amateur use as well.

Slow Development

A TIP from an old-timer recently received by this department: In order to get a good scale of tones in the portrait negatives he develops he uses a pyro-metol formula but starts development with but a third of the carbonate called for. After development has proceeded for a while he observes progress by the light of a red lamp (he uses portrait film, orthochromatic) then switches off the light and continues, studying the negative every little while. When the image seems to be coming up, but slowly, he pours in another third of the carbonate, being careful to lift the batch of negatives by one end so that the carbonate is well mixed in the developer solution be-

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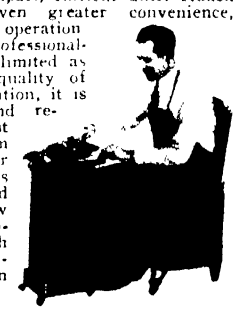

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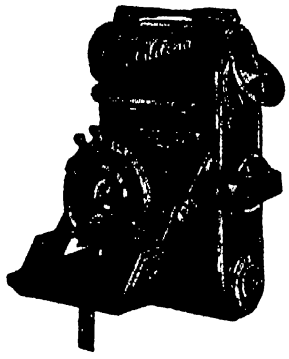

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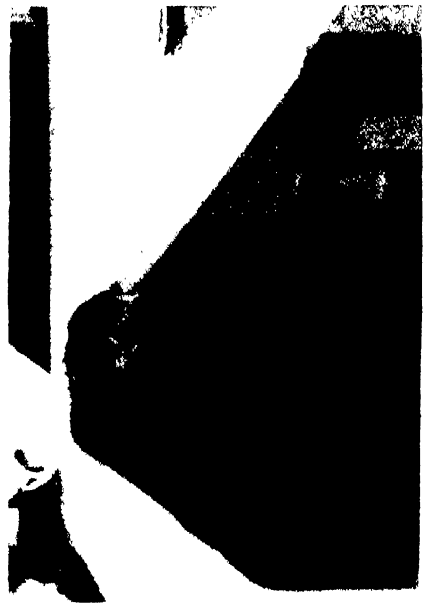
fore affecting the negatives. Otherwise unequal development would result. Finally, he pours in the last third of the carbonate. The whole procedure takes about a half hour but the photographer says the method is ideal for the long-scaled negatives he wants.



"The Flower Seller"

Chance Compositions

NOW and then we come across a subject accidentally well composed and ready for a snapshot. Such a one as "The Flower Seller" is a case in point. The figure is placed just right in relation to the shadow and the contrast of light and shade lends atmosphere to a subject which would have been worthless without it. The picture was made in late afternoon from an elevated railway platform.

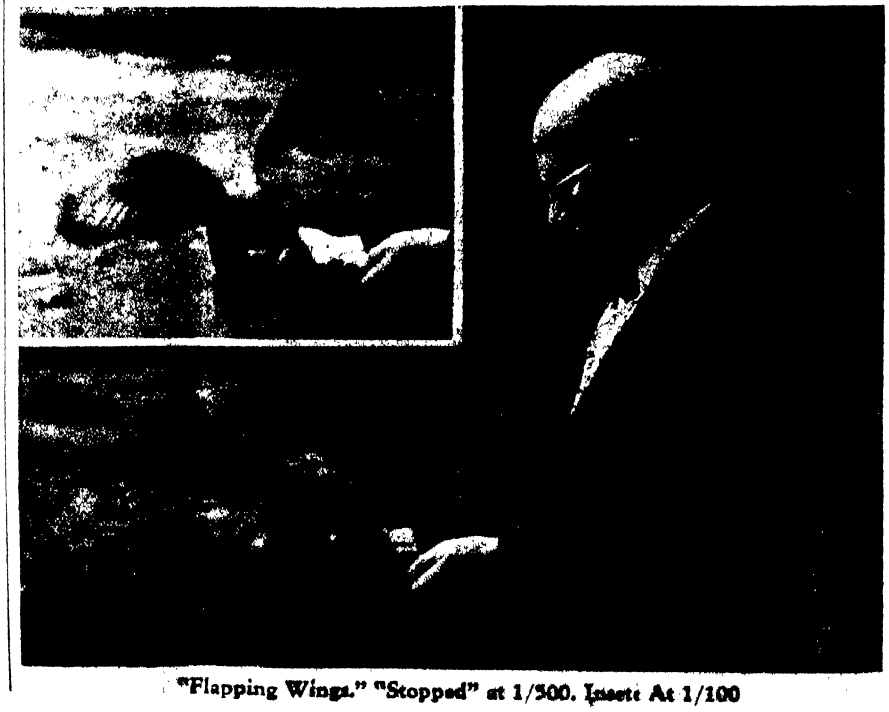
Tree Reflections

IN "Reflections" this department offers a suggestion for the proper manner in which to photograph the reflection of trees in water. The reflection of the trees alone might prove a little puzzling, despite the strip of shoreline in the lower right-hand corner, the viewer being inclined to turn the picture upside down in an effort to determine whether the picture was that of the trees themselves or their reflection. As it is, the lily-pads on the water's surface not only make the scene clear but also add contrast and interest. A good portion of shoreline in the upper part of the picture or, better still, a human subject looking down into the water, would also be effective.

"Reflections"

Flapping Wings

IT takes 1/500th of a second to stop the motion of a pigeon's wings, and here is the evidence. The use of peanuts as bait made the pigeon in the illustrations fly to the feeding hand three times in succession, making possible three exposures (only two are reproduced), the first at 1/100th, the second at 1/200th and the last at 1/500th of a second. The first is quite hopeless, of course, the second just fair, but no fault can be found with the third, for here the wings are as "frozen" as if purposely posed.



"Flapping Wings." "Stopped" at 1/500. Insets At 1/100

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 289)

solution attach themselves to the negatively charged surfaces of the metal in such a way as to reduce its effective contact with the liquid. They have further found that the amount of an amine needed to minimize corrosion is related to the cross-sectional area of its molecule. The area covered by each molecule is extremely minute, but it has been shown that if the ions can be made to assume a tilted instead of an erect position with respect to the metal surface, smaller amounts of amines are effective.—*D. H. K.*

Road Taxes for the Flier

IN a recent article "Where Are the Private Fliers?" by Robert Crawford, published in *The Sportsman Pilot*, Mr. Crawford has the following pertinent remarks to make concerning gasoline taxes:

"Gasoline is too high. Why should the flier be heckled with road taxes? Most states realize that the average flier won't take the trouble to ask for his refund, or go through the various red-tape procedures to get it, and the various states pocket the money. Texas charges you one dollar each time for the privilege of filing a claim, so how many fliers do it? In the meantime, thousands of dollars roll up in the Texas treasury and they can smile. Is this a racket?

"Arkansas leads the way by doing away with the gasoline tax for airplanes entirely. So, fill up, gentlemen, in Arkansas. The Carolinas and Tennessee as well as Colorado, Wyoming, and Utah grab as many pennies as they can and tell you to whistle for your refund. Do these same states disrupt transportation by taxing each railroad ticket 5 cents every 15 miles of travel? What a holler would go up if they did! Are there five fliers in the United States who travel cross-country and take the trouble to demand their rightful refund? I doubt it. If a hundred of us would do as I do, make *every* demand for a refund and with each letter to a tax department write a PROTEST and demand sensible handling of the tax situation, there would be a change.

"Remedy: do away with all State taxes of gasoline for airplanes. Substitute a two-cent Federal tax to be used in building of new airports *only*."

Preventing Collision in the Air

LONDON *Flight* carries an interesting account of an instrument entitled the Radiaura, designed to prevent collisions at sea and tested with satisfactory results by the British National Physical Laboratory.

As constructed at present, the Radiaura is too bulky for aircraft use and only works in two dimensions. But reduction in weight and modification for use in three dimensions should not be too difficult. We would then have an apparatus for preventing collisions in the air whose utility would be obvious.

The Radiaura makes use of the cathode-ray tube. For those readers who are not too deeply versed in radio, it may be stated that the cathode-ray tube consists of an electric filament placed at the narrow end of a conical glass tube, almost completely evacuated of air and containing a mere trace of helium. Near the filament, or cathode, is a circular plate, technically known as the anode, through the center of which is a hole. When the filament is heated by passing a current through it, and a suitable electric potential is applied to the circular plate, a stream of electrons is shot from the filament or cathode to the anode. Because there is a hole in the anode plate, the electrons pass on and hit the flattened base of the cone. If the base of the cone is coated with a fluorescent material the point of impact shows up as a spot of light.

The stream of electrons is of negligible weight, and can be instantly deflected by charging pairs of plates, disposed at right angles to one another, or by electro-magnetic coils. Because of the low weight of the electrons the jet can be deflected very rapidly. If the motions of the jet are fairly rapid, persistence of fluorescence makes the path traced out by the spot appear as a line of light on the screen.

The cathode-ray tube is, of course, only one element of the "collision preventer." In conjunction with the tube a pair of loop aerials are fixed in vertical planes at right angles to one another. These aerials, suitably tuned and adjusted, influence the line of light produced by the cathode-ray tube.

As soon as a transmitter carried by another vessel (sea or air) comes within range, its waves influence the two loop aerials, and the line of light appears in the tube. The line of light gives the bearing of the approaching ship, and the length of the line increases as the approaching vessel comes nearer.

Very simple in principle, the apparatus is quite complicated in actuality. For three-dimensional use, it may be conjectured that two cathode ray-tubes might be necessary and also a duplicate set of aerials. But once the electrical technologists really get busy, with their vast scientific resources, the practical difficulties should soon vanish.

With increasing air traffic, and increasing blind flying, an instrument such as the Radiaura would be highly welcome.—*A. K.*

The Mystery of the Constant-Speed Propeller

THE original Hamilton Standard controllable-pitch propeller—which was awarded the Collier Trophy as the outstanding aeronautical development of the year 1933—was limited to two pitch positions: a low-pitch position for take-off and climb, and a high-pitch position for high speed. This was a great step forward and considerably improved the efficiency of operation. But a two-pitch manual setting is not entirely satisfactory, since the airplane needs a multiple variation in speed to suit all conditions of flight. Also, the pilot has already so much to think of that manual control is somewhat of a burden. Again there must be some kind of control of the engine—no over-speeding in a dive, no overloading at take-off or in a sharp climb.

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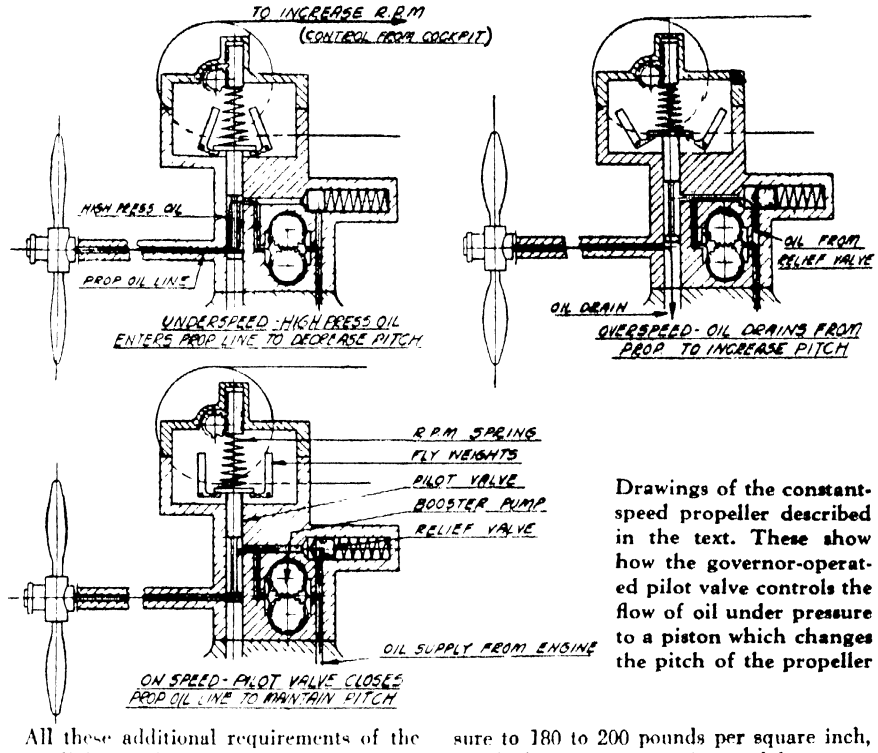


Drawings of the constant-speed propeller described in the text. These show how the governor-operated pilot valve controls the flow of oil under pressure to a piston which changes the pitch of the propeller

All these additional requirements of the controllable-pitch propeller have been met by the constant-speed propeller, which is being adopted on many airlines and is giving splendid service.

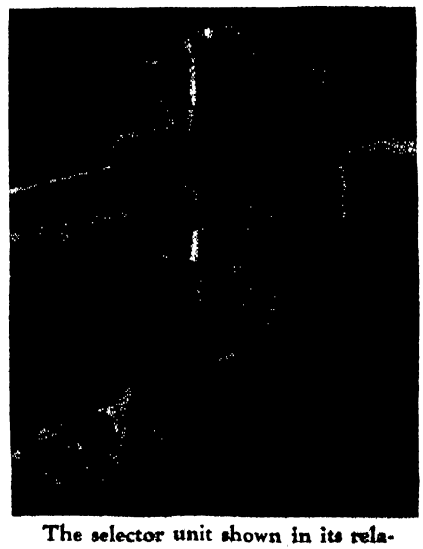
We have in these notes hinted at the underlying principles of the constant-speed propeller, but an authoritative description of the controlling mechanism has hitherto not been available. This mechanism is so ingenious and "satisfying," that a detailed description is fully justified.

The basic principle of the automatic change of pitch is very simple. Counterweights acted on by centrifugal force tend to increase the pitch as the engine speed and the speed of the plane in level flight go up; oil pressure supplied from the engine works in the opposite direction. The two conflicting forces so balance one another that the pitch is adjusted to keep the engine speed always the same, no matter what the throttle setting or the flight condition may be.

The sketches illustrate the automatic pitch selector. A simple gear pump, driven from the engine and called "booster pump" in the diagrams, boosts the engine oil pressure to 180 to 200 pounds per square inch, at which figure it is maintained by means of a simple relief valve.

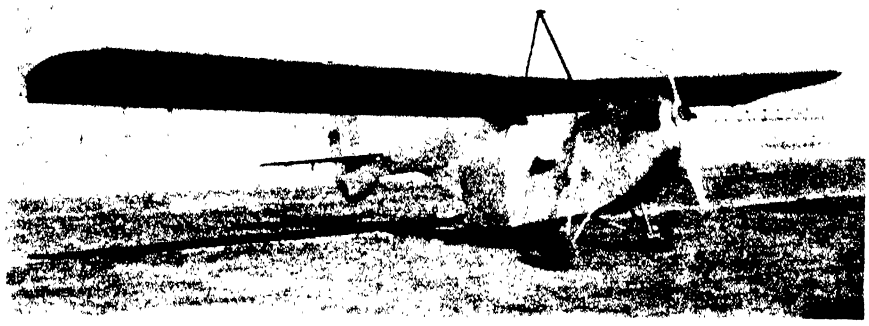
The heart of the "selector" is the pilot valve. The governor, consisting of counterweights or "fly weights" tends to fly out and compress the spring while raising the pilot valve. On the other hand, when the engine is not rotating fast enough, the force of the governor becomes less than that of the spring, and the pilot valve goes down. It then uncovers the port leading to the propeller feed line as shown in the "Underspeed" sketch. This allows oil under pressure to flow from the booster pump to the propeller, where a piston working in a cylinder decreases the pitch of the propeller, allowing the engine to speed up accordingly. Everything is exactly the converse in the overspeed condition.

There is also a control from the cockpit which can be made to change the tension of the governor spring, thus changing the fixed revolutions per minute to some other



The selector unit shown in its relation to the constant-speed propeller

Cut-away view of the selector unit. Compare it with the drawings above



The National Airplane, a low priced flivver plane

desired figure. In the "On Speed" position, no oil flows to the propeller, and the relief valve opens so that the pressure-boosted oil just circulates 'round and 'round.

In one of the photographs the selector unit is shown in relation to the controllable-pitch propeller itself with the feed lines clearly indicated. With the actual mechanism of pitch variation, the reader is no doubt already familiar.

The constant-speed propeller has a number of advantages in addition to improving the performance in take-off and at high speed. With this device it is possible to go through various maneuvers in acrobatic flying without the necessity of readjusting the throttle to prevent the engine overspeeding. On multi-engine airplanes it is evidently important to keep the engines on either side of the fuselage always in synchronism. This is quite a difficult task for the pilot, which he is very happy to turn over to the selector. There are also other technical possibilities in the device which help to explain its popularity.—*A. K.*

The Flivver Airplane

A RECENT newspaper story was entitled "Tests Reveal Air Flivver at Low Price Nearer. Six Types of Experimental Machines Used in Inquiry for Commerce Bureau."

There is not the slightest doubt that announcements of this character do a great deal of harm to private flying in the United States, although we do not know whether the Department of Commerce or the newspapers themselves are to blame.

The Department of Commerce announced a 700-dollar-airplane nearly three years ago, and nothing of the kind has appeared under its auspices. The experimental planes produced under its program cost at least 3000 dollars. The argument is that they are much safer than ordinary planes, but the ordinary planes are licensed by the Department itself, are faster than the new variety and are actually on the market, not in the experimental stage.

As a matter of fact the flivver airplane is right here with us now. We know definitely that one company in the middle-west, selling a two-seater under 1500 dollars, sold 280 airplanes in less than six months, and has recently placed an order for a million dollars' worth of engines. Other companies selling machines in the same price range are doing almost equally well.

Our recommendation is that both the Department of Commerce and the newspapers should cease announcing "flivver airplane near" or "coming" and give due credit to the successful efforts of today's manufacturers.

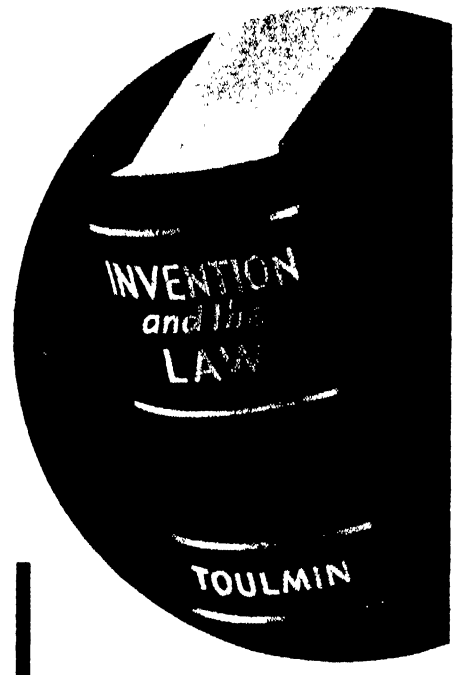
By a coincidence, and as if to underline the points of the above remarks, we have just received a description of the National Airplane, which is definitely in the low price range. The workmanlike small machine is shown herewith. It costs less than a thousand dollars, has a top speed of 85 miles per hour, and the gas consumption is given as $2\frac{1}{2}$ gallons an hour. The engine develops 35 horsepower in its two opposed cylinders, the weight empty is 465 pounds, and the gross weight is 900 pounds. At least some one is actually building flivver airplanes in this country.—*A. K.*

Will New York City Lose Again?

WHEN the first transatlantic airplane service is put in operation, it would seem logical that New York City should be the American terminal. But New York City lost the opportunity of being the domestic air terminal of the east when it allowed Newark to build an airport that was more desirable than Floyd Bennett Field. Now history is likely to repeat itself. Charleston, South Carolina, and Baltimore, Maryland, are both actively competing for the honor of building the transatlantic air terminal. Both cities have pledged 1,500,000 dollars to make the necessary improvements at their respective municipal airports, while officials of Pan American are actively negotiating with the mayors of these cities. This great operating company is apparently of the opinion that the more southerly cities would be more suitable for winter operation, and that there would be very little loss of time on the southerly route (Bermuda, Azores, Portugal) if passengers and mail had to be transferred to fast landplanes at either Baltimore or Charleston. Moreover, New York City apparently has considerably less local pride, and that is probably the main reason why it will lose out in the competition!—*A. K.*

Carbureter De-Icing

WINGS, struts, tail surfaces, and the propeller of the modern plane are now effectively protected against ice formation. Ice in the carbureter is the next peril to conquer. The Air Commerce Bulletin describes a number of devices for eliminating or preventing this trouble. Ice in the carbureter checks the flow of the fuel mixture and the phenomenon may occur when the



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outside temperature is as high as 50 degrees or 60 degrees, Fahrenheit, because the vaporizing fuel causes a temperature drop.

One type of carbureter which has been successful in tests is the Chandler-Groves. Much of the icing difficulty in the carbureter arises from contact of the fuel mixture with carbureter parts after vaporization has caused cooling. The Chandler-Groves carbureter is designed on unconventional lines in such a fashion that the mixture leaves the carbureter immediately after vaporization. No contact with parts; no icing.

In a conventional Stromberg carbureter the difficulty has been met in quite another fashion. The moment ice begins to form, it closes a small aperture in the barrel and a mechanism controlling an alcohol valve functions. The alcohol injected into the fuel mixture breaks up the ice. There is also a novel arrangement for preheating the air without raising it to such a temperature as to lower the efficiency of the engine.

Another line of attack is in a special mixture developed by Dr. C. C. Callis. A minute amount of the secret stabilizing fluid, added to the carbureter for not more than a minute, will dissipate the ice. Tests at the School of Aeronautics, New York University, and at the Bureau of Standards agree as to the splendid properties of the Callis stabilizing fluid.—*A. K.*

Removing Fluorine from Drinking Water

IN many parts of the country injury to teeth has been traced to the presence, in minute amounts, of fluorine in drinking water. In some way the presence of compounds of fluorine in drinking water causes spotting and disintegration of the enamel of teeth, and hence it is extremely important in those localities where water supplies contain this element to remove it before drinking the water.

Many researches have been directed toward finding an efficient and economical method for doing this, and several methods, more or less successful, have been proposed. The latest and so far the most practical solution to this problem is to pass the water containing fluorine over a bed of activated alumina. Apparently the alumina absorbs the fluorine and makes the water safe.

To apply the method a small unit containing less than 10 pounds of alumina in a bed 6 inches deep and contained in an enameled vessel 12 inches deep and 8 inches in diameter has been built which will remove fluorine from 250 gallons of water before a renewal of the alumina is required. Such a unit can be used for treating water in a single household and the replacement of the spent alumina is easily accomplished. Larger units for treating municipal water supplies are yet to be developed. It seems probable that treatment of only that part of a water supply used for drinking will be preferred to treating the whole supply, because of cost.—*D. H. K.*

Science in India

TO many in our western world India is or has been the home of mystic cults and occultisms, but western science has taken hold there and has come to fruition in several forms, one of which is the relatively recent foundation of sound scientific journals. Two of these, *Current Science* and *Science and Culture*, reach the editor's desk each month and are very similar to high-grade scientific journals elsewhere. The former is patterned largely after *Nature*, of London, is quite technical and is published at the Indian Institute of Science, Herbal Post Office, Bangalore, India, under the editorship of Prof. C. R. Narayan Rao. The latter journal is a little more popular and is edited by the well-known astronomer Prof. M. N. Saha, at 92 Upper Circular Road, Calcutta. Both are in English.

It is good to see that India now contains enough persons of scientific background to support such excellent journals. For years we have received, unsolicited, from that collection of eastern nations various journals which contained a dismaying mixture of science and superstition oddly blended together in one organ. Here in the west the two are more likely to be separated, journals being either scientific or occult. But the fact that we have in this country so many journals devoted wholly to astrology and so on puts us in no position to patronize India.

Fish Have Hard Life in Muddied Streams

THOUSANDS of fishing sites that once were the joy of fishermen will provide less sport and yield fewer fish than ever before as a result of soil erosion, says E. G. Holt, head of the wildlife section of the Soil Conservation Service.

"In all parts of the country, muddy waters and silt are diminishing the stock of fish," he said. "The reason is plain. Eggs laid by game fish cannot survive when streams are full of mud and erosion debris. Also, blanketing of the bottoms of streams with ooze and silt is destructive to food supplies, such as insect larvae, worms, and small plants."

The decreased supply of game fish in inland streams and their tributaries has not come about suddenly. Unwise use of the land over a period of years, resulting in an excessive run-off of rain-water which washed tons of soil into the streams, has been steadily cutting down the rate of propagation.

Mr. Holt pointed out another reason why soil erosion can be blamed for spoiling

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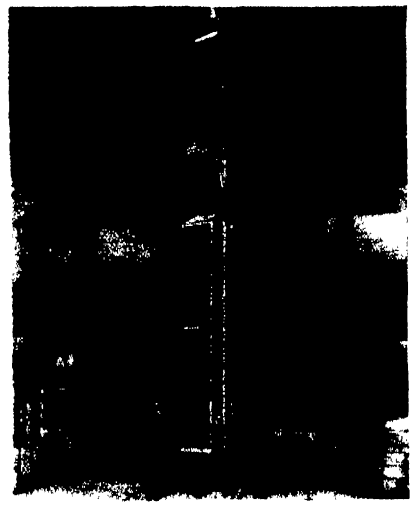
once-popular fishing locations. Many species of fish will thrive only in relatively deep, clear, running water, and when silt fills stream channels the fish leave, because they cannot live in the sluggish, muddy waters of shallow streams.

"Until there is more general control of soil erosion fishing conditions will not improve greatly," he said. "Unless silting of stream channels is stopped, there is no reason to expect that the fish can be brought back and the stock restored."

Mine Cage

MINE shafts are not like elevators in business buildings; space is restricted and the traveling distance often runs to many hundreds of feet. Hoisting cages must, therefore, be designed to meet this problem.

The combination vertical ore skip and double deck hoisting cage shown in an accompanying illustration is one of several



Ore skip and mine hoisting cage

of identical size designed and fabricated by Allis-Chalmers Manufacturing Company. In this design, the weight was reduced by nearly one third of that of similar existing combined skips and cages by the use of a special high tensile strength alloy steel throughout. The reduced weight of this new equipment is sufficient to permit one mine to operate now to a depth of 800 feet greater than possible heretofore and all without increasing the rope pull on the existing hoisting equipment. These cages are to be used in a deep lead-silver mine in northern Mexico.

Lightning and Atmospherics

IT is now generally agreed that the majority, if not all, the atmospherics encountered in radio communication originate in lightning flashes. When the storm is close to the receiver, it is possible to identify the stronger atmospherics with the neighboring flashes. In a recent communication, Mr. P. F. Fyson, Langherne House, Rushwick, Worcester, England, claims to have observed that the atmospheric crackle produced on a broadcasting receiver was heard before the lightning flash which caused it was perceived visually. If this difference in the perception of the two effects is real—it obviously needs verification by other observers—it would appear on first considera-

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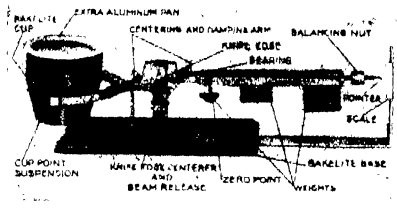

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tion that the human eye is rather more sluggish in its operation than the ear; and Mr. Fyson suggests that this may be due to the time required for the chemical change in the retina to affect the optic nerve. An alternative explanation, however, may be found in the fact, which has arisen from recent research on lightning, that an intermittent electrical discharge appears to precede the actual main lightning flash. It is possible that this discharge may be invisible and yet may be capable of producing audible effects on a radio receiver. These sounds may thus be heard a very short time before the visible flash was observed.—*Nature* (London).

New Facts Help Timber Growing in South

SEVERAL outstanding accomplishments, including the development of a method for procuring increased germination of black locust seed, improved methods of artificial reforestation in the South, as well as facts in regard to influence of severe fires on pine sapling stands and results of truck logging in second-growth shortleaf and loblolly pine, were developed last year by the Forest Service, U. S. Department of Agriculture.

The experiments were carried out by the Southern Forest Experiment Station at New Orleans, one of 12 regional forest experiment stations in the United States.

Development of the method for improving germination of seed from black locust trees was an important accomplishment, as the black locust is widely used in erosion control work and also is considered a valuable adjunct to the farm woodlot as it is an excellent source for fence posts. During 1935 more than four tons of the black locust seed were treated in Mississippi alone. The treatment involves soaking the black locust seed in concentrated sulfuric acid for a short time prior to planting in the nursery.

Heat-Proof Windows

A NEW coating to be put on glass windows, which allows 90 percent of the light to pass but which filters out heat rays, is said to reduce the temperature inside a building by as much as 10 to 15 degrees and to minimize glare.—*D. H. K.*

And the Botanist Missed His Reply!

ACCORDING to *Nature* (London), Sir William Fraser relates the following event in the scientific world:

"The Duke of Wellington . . . received a letter . . . from the eminent landscape designer and great authority on botanical matters, J. C. Loudon. It was . . . to this effect:

"'My lord Duke: It would gratify me extremely if you would permit me to visit Strathfieldsaye, at any time convenient to your Grace, and to inspect the Waterloo beeches. Your Grace's faithful servant, J. C. Loudon.'

"The Waterloo beeches were trees that had been planted immediately after the battle of Waterloo, as a memorial of the great fight. The Duke read the letter twice, the writing of which was not very clear; and, with his usual promptness and politeness, replied as follows; having read the

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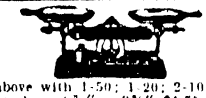

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"This letter was received, as may be supposed, with great surprise by the Bishop of London. He showed it to the Archbishop of Canterbury, and to other discreet persons: they came to the melancholy conclusion that the great Duke of Wellington had evidently lost his senses. The Bishop of London (Blomfield) declared that he had not written to the Duke for two years; and to receive this extraordinary information puzzled the whole Bench of Bishops."

Scheming to Teach Make-up to Apples!

BECAUSE of the desirability of high color on apples in the markets and because of the importance of apple-growing in West Virginia, it was deemed advisable to undertake an investigation of the red pigment of the apple at the Agricultural Experiment Station at Morgantown.

Many of the earlier investigators of plant coloring matter thought that all red, violet, and blue flowers contained the same pigment, believing that its color was changed by conditions prevailing in the various cell saps. However, it is now known that there are a considerable number of naturally occurring substances which produce these varying shades of color.

The red coloring matter of the winesap apple has been shown to belong to a group of complex organic substances known as anthocyanins of which there are several fundamental types. Like other anthocyanins the pigment occurs in the apple skins in the form of a glucoside. It was identified as idaein chloride, a pigment which occurs also in the cranberry.

Now that the pigment of the apple has been isolated, its chemical structure established, and some of its properties determined, it is planned to carry the study into the field and investigate the various factors which influence the formation of the pigment by the tree during the growing season.

Half Our Hawks Do More Good Than Harm

CONTRARY to common opinion, not all hawks are chicken thieves. Six of the 17 most common species are good friends of the farmer. At least half do more good than harm, says the Bureau of Biological Survey, United States Department of Agriculture, in a new circular, "Food Habits of Common Hawks."

Some hawks occasionally kill chickens or useful birds, but for each of these a hawk usually eats dozens of rodents and many insects. Sparrow hawks, for example, seldom prey upon other birds, yet they often are blamed for misdeeds of other hawks. They could more appropriately be called grasshopper hawks, says the circular, as the chief food found in 491 of 703 sparrow

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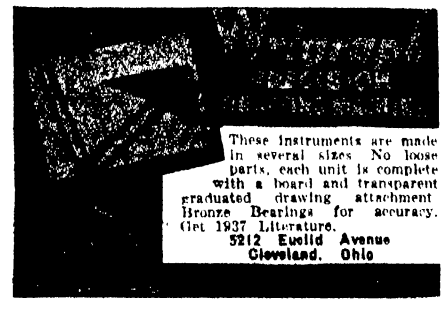

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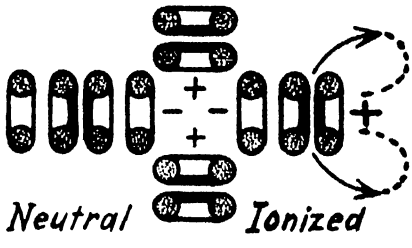

Helium atom in cross-section. Substitution of deuterons for protons produces heavier isotopes. Copyrights 1933 and 1934 by Carl F. Krafft.

These diagrams are not mere symbols or speculations, but purport to be true representations of the atom as it actually exists in space. They are supported by proof of the most conclusive character. They are presented as a challenge to our metaphysical physicists whose fantastic speculations about photons and the fourth dimension have culminated in the announcement that the atom cannot be represented diagrammatically.

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hawk stomachs was grasshoppers. Studies of the Swainson's and American rough-legged hawks show they are almost entirely beneficial in feeding habits.

Red-shouldered, broad-winged, and ferruginous roughleg hawks are preponderantly beneficial, seldom in need of control. The red-tailed hawk and the golden eagle are more beneficial than injurious. The marsh hawk and prairie falcon each have about equal proportions of harmful and beneficial habits. Both the bald eagle and osprey are harmful and beneficial in about equal proportion. Pigeon hawks tend to be destructive but may be tolerated in small numbers. Goshawks, sharp-shinned, Cooper's, and duck hawks do more harm than good.

Remains of poultry were found in nearly half of the 243 goshawk stomachs examined, and in only two of the 944 sharp-shinned hawk stomachs. The sharp-shinned hawk, however, feeds largely upon useful birds.

One of every 12 meals eaten by the red-tailed hawk, or hen hawk, probably consists of chicken. Otherwise, it is a good "mouser" and does more good than harm. Where poultry is not protected by pens or runs, this hawk has to be controlled.

Control measures are advised against offending hawks only, and not against the entire race. Copies of the Circular, No. 370, may be obtained from the Superintendent of Documents, Washington, D. C., at 5 cents each.

Chain Loop—Humane Animal Trap

TRAPPING animals for fur, or to remove them as nuisances, promises to become a much changed and far more humane business than it has been during the long reign of the steel trap, through the introduction of an entirely new type of trap, the invention of Vernon Bailey, veteran biologist of the United States Biological Survey. Mr. Bailey's trap substitutes for the old-time steel jaws a firm-holding but painless chain loop, somewhat reminiscent of the string snares we used as boys to catch ground-squirrels and gophers. Only it is much stronger, wholly automatic in action, and can be built large enough to capture a grizzly bear.

Mr. Bailey has spent a long lifetime among animals, as their student and their friend. He has hated to see them tortured by steel traps—and often escaping from

Humane animal trap—set

Humane animal trap—sprung

them, at the cost of being crippled for the rest of their lives. Yet he recognizes the legitimacy of the fur trapping industry, which has for a long time depended largely on steel traps. To produce a better trap, that would never lose its catch and yet never torture or maim the animal, has been his ambition for many years.

The "Verbail" trap—as his friends have named his invention—is built very much like a bow. There is a strong but flexible spring-wire arch, with a piece of light chain attached to each end. The free end of each chain terminates in a ring, which slides freely around the opposite chain, thus forming an easily closing loop.

When the trap is set, a four-legged "spider" of light metal holds the loop open, wide enough to admit the foot of the animal to be caught. When the animal steps into the loop, the jointed legs of the "spider" let go and the spring flies apart, throwing the loop upward and at the same time pulling it shut—and the animal is caught.

The first reaction of a trapped animal always is to jump and pull. In an anchored steel trap, this always ends in a violent jerk, increasing the shock and pain of the jaws' first hard snap, and not unlikely breaking the animal's leg—if the steel trap has not already broken it.

In the "Verbail" trap, the effect is quite different. The chain cannot break the animal's leg, and its jump and tug are stopped by the "yielding resistance" of the spring that holds the chain. As a rule the animal, not being in any pain, soon accepts the situation philosophically and lies down to wait for what may happen next.—Copyright *Science Service.*

Controlling Gas Explosions

RATE of rise of pressure during the explosion of a gas mixture is the most important characteristic of such explosions. This rate depends upon the temperature of the mixture when the explosion starts. For each mixture of flammable gas and air has been found a critical temperature which gives the fastest rise of pressure. The variation in performance of internal combustion engines between winter and summer can be traced to the differences of the initial temperature of the gas mixture in the cylinder. An improvement in operation should result from avoiding these critical temperatures by control of engine cooling.—*D. H. K.*

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EVALUATION OF MINIATURE NEGATIVES, by J. W. Orelup, describes an instrument which, with a photo-electric exposure meter, automatically gives the following data for 35 mm. photographic negatives: printing time; grade of paper; fog due to light or chemicals; whether processing of the negatives has been correctly carried out. *Write for Bulletin 1136B, Scientific American, 24 West 40th Street, New York, N. Y.—3-cent stamp.*

THE TROYVILLE MOUNDS, CATAHOULA PARISH, LA., is an archeologist's account of the excavation of a large Indian mound at Jonesville, La. *Superintendent of Documents, Washington, D. C.—20 cents, cash.*

THE USE OF CELLULOSE, CASEIN, AND OTHER PRODUCTS IN SYNTHETIC PLASTICS AND RESINS, by Carpenter and Kucera. The main chemical reactions underlying the processes of increasing importance to the synthetic resin and plastics industry are given, insofar as they are known. The manufacture, various properties, and numerous applications of phenol aldehyde, cellulose, vinyl and styrene, glyptal, urea, and casein plastics are discussed. *New York State Agricultural Experiment Station, Geneva, N. Y.—Gratis.*

STATE AND COMMUNITY ORGANIZATION FOR SAFETY is a 24-page booklet which outlines specifically the formation of groups for the promotion of highway safety. *National Safety Council, 20 North Wacker Drive, Chicago, Illinois.—Gratis.*

HOW TO ABOLISH POVERTY. By George L. Record. Described as "a program of political action to end the present and prevent future depressions, provide permanent employment for all, and increase the production of wealth and secure its equitable distribution."—*George L. Record Memorial Association, 26 Journal Square, Jersey City, N. J.—$1.00.*

ILLUMINATION HANDBOOK serves as an authentic source of lighting facts of particular interest to electricians, lighting fixture dealers, and so on. It provides a mass of detailed information on specialized fields of illumination. Deals with interior lighting, display lighting, flood lighting, underwater lighting, and highway lighting. *Commercial Engineering Department, Westinghouse Lamp Company, Bloomfield, N. J.—10 cents.*

WHY WE SEE LIKE HUMAN BEINGS is a book published by the Better Vision Institute to protect and preserve eyesight. A great deal of information about eyes is compacted into a small space in this small book. *Better Vision Institute, 50 Rockefeller Plaza, New York, N. Y.—$1.25.*

FURTHER EVIDENCE ON THE DEPENDENCE OF TERRESTRIAL TEMPERATURES ON THE VARIATIONS OF SOLAR RADIATION, by C. G. Abbot, Secretary, Smithsonian Institution, is a follow-up of earlier papers on a hoped-for method of weather prediction, which has now received the backing of Professors Millikan, K. T. Compton, and Bowman, and Chief of the United States Weather Bureau but failed to receive requested financial backing from a Congress more interested in boondoggling. *The Smithsonian Institution, Washington, D. C.—5 cents.*

PROCEEDINGS OF THE SECOND DEARBORN CONFERENCE OF AGRICULTURE, INDUSTRY AND SCIENCE. A 400-page transcript of the papers on power alcohol, starch and sugars, plastics, cellulose, soy beans, insecticides and fertilizers, delivered at the recent conference held under the sponsorship of the Farm Chemurgic Council and the Chemical Foundation, Inc. *The Farm Chemurgic Council, Dearborn, Mich.—50 cents.*

R C A REVIEW is a new quarterly journal of radio progress of which the July 1936 issue is Volume 1, Number 1. It is dedicated to making a permanent record of new information on electronics which is constantly being acquired in research laboratories. The material is of particular interest to students and others inclined toward the technical side of radio. *RCA Institutes Technical Press, 75 Varick Street, New York, N. Y.—Single Copies 50 cents, Subscription $1.50 per year.*

CONSTELLATIONS, by James Stokley, Director of the Fels Planetarium, Philadelphia, is an attractive pamphlet with good, clear, neat monthly maps of the constellations, with appertaining text of a rather light nature. *The Franklin Institute, Philadelphia, Pa.—35 cents, stamps or money order.*

SOLAR CAPACITORS is a comprehensive booklet prepared for engineers and laboratory executives in radio and other electrical fields where condensers of various types and capacities are in constant or occasional demand. This is more than an ordinary catalogue; it is a directory of capacitors. *Write for Bulletin 1136A, Scientific American, 24 West 40th Street, New York, N. Y.—3-cent stamp.*

WORLD CHEMICAL DEVELOPMENTS IN 1935 is a paper bound book of 197 pages, giving a complete review of chemicals throughout the world for the year named. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

THE FORESTRY PRIMER, 60th Forestry Anniversary Edition, is dedicated to the memory of Franklin B. Hough, the first forest agent. By Charles Lathrop Pack, it tells the story of the forests of the United States, their uses and abuses, their status at the present time, and the outlook for the future. *American Tree Association, 1214 Sixteenth St., N. W., Washington, D. C.—Gratis.*

A GOOD PICTURE EVERY TIME, by Alex. Strasser, gives the ironclad rules of photography and then tells when to break them in order to achieve the finest possible results. Beautifully illustrated with photographs to supplement the text. 40 pages plus space for notes. *American Photographic Publishing Company, 428 Newbury Street, Boston, Mass.—40 cents.*

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By Daniel W. Josselyn

MOST of us would answer the question in the title of this book very bluntly: "Because we have too blooming much work to do and have to get it done." There is, however, another answer, and that is that we do not make the most of our energy. Mr. Josselyn seems to have quite a reputation as a specialist in reviving fagged office athletes and in this volume gives valuable information to the sedentary worker that will enable him to do more work in a given time with less fatigue. In just over 100 pages he gives some very sane advice on diet, on exercise, and on sex in their relation to the restoration of energy for tired business men and business women.—$1.10 postpaid.—*F. D. M.*

ELEMENTARY PHOTOGRAPHY

By Neblette, Brehm, and Priest

IF you have little or no knowledge of physics and chemistry, yet want to delve somewhat into the whys and wherefores of photography, this book will be of great assistance. Without getting beyond your depth, you will find here a thorough background of the elementary principles of producing negatives and prints. Such background, properly utilized, will enable you to do better photography. The book was written as an easy-going text for students, but its lucidity and logical arrangement adapt it to the needs of anyone who fits into the general classification mentioned in the first sentence above.—$1.15 postpaid.—*A. P. P.*

EARTHQUAKES

By Nicholas Hunter Heck, Chief, Div. of Terrest. Mag. and Seismology, U. S. Coast and Geodetic Survey

AT last there is a general, elementary treatise on seismology to recommend to the many who, during the past years, have asked for one but had to be told that none existed. Captain Heck's new book covers earthquake science from all angles, as indicated by its chapter heads: Earth Vibrations; Effects of Earth Tremors; Cause of Earthquakes; Release of Forces; Earthquake Study Without Instruments; Earthquake Study with Instruments; Present Seismographic Sections of the United States; Earthquake Records and Their Interpretation; Location of Earthquake Epicenters and Foci; Seismic Belts of the Earth; Description of Great Earthquakes; Earthquakes of the United States; Regional Investigations; Safe Construction in Earthquake Regions; Summary of Earthquake Information; History of Seismology. In all, 218 text pages of solid, compact matter. The chapter on instruments describes the various types. This is not, however, a book on how to make seismographs, for none exists, but it gives more insight into the instruments than the baffled beginner has yet found available. There have been only eight notable books on seismology in 30 years and most of these are either out of date, in a foreign language, or very abstruse. Commander Heck's book is a landmark.—$3.65 postpaid.—*A. G. I.*

AUDUBON

By Constance Rourke

BIRDS come to mind almost as a synonym for the name of the great naturalist whose name this book bears. This is the story of his life, his work, his personality, his unflagging energy which drove him from Pennsylvania to Texas, from Florida to Labrador in his unending search for birds. Miss Rourke has made a life study of birds and of bird pictures and prints and, in addition, has traveled over much of the route followed years ago by Audubon. She is, therefore, eminently fitted for the job of portraying sympathetically the life of this great naturalist. The present volume, of over 300 pages, is profusely illustrated with black-line drawings in woodcut style and has, in addition, reproductions of 12 Audubon prints, beautifully done in his original colors.—$3.15 postpaid.—*F. D. M.*

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By William Stephen Grooch

ADVENTURE is still to be found on the face of this old world of ours—adventure as thrilling and exciting as any encountered when knights were bold or privateers sailed the seas. Here is a taste of it, from the pen of a man who participated largely in the pioneering air-transport service across the Pacific. With but little background to guide them, other than that secured in the South American service, a group of American adventurers have conquered desolate islands in the Pacific, established air bases complete with radio stations and other necessities of modern avigation, and have laid the foundation for what will undoubtedly be an important link in world commerce. The author of the present book took an active part in this work. He tells his story of it as he saw it, recording also those little human phases that lend flavor to a narrative. No fiction could be more gripping than this simple tale of modern achievement, told without pretense of "highbrow" writing. As you read, you lose sight of the fact that the printed page is before you; the author might almost be telling his story across a couple of tall, cool glasses. Well illustrated; 205 pages.—$2.65 postpaid.—*A. P. P.*

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MORE SIMPLE SCIENCE

By Julian Huxley and E. N. da C. Andrade

THE sequel to a recent book, "Simple Science" by the same authors, which dealt with mechanics, physics, chemistry, and biology, this book covers the earth's climates, earth history, the chemistry of life, soil, agriculture, artificial selection, and a short history of science. Most mature lay readers would find it very elementary—suitable for a lad of 12 to 14 or a reader whose knowledge of science is slight.—$2.65 postpaid.—*A. G. I.*

ELECTRON DIFFRACTION

By R. Beeching, A. R. C. S., B.Sc.

PURE science research has opened many avenues for the study of matter. One of these avenues is supplied by the electron and its atoms. Through electron diffraction it becomes possible to study the arrangement of atoms in a

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YEARBOOK OF AGRICULTURE, 1936

By the United States Department of Agriculture

HERE is something commendable: the dull, statistical, annual reports of the Secretary of Agriculture have now been reformed, the statistics relegated to a separate book for statistics fiends, and the same space filled with material which should be of immense value to the practical farmer and breeder of plants and livestock, instead of following in the route of old mail order catalogs. It contains a treatise on the science of genetics and its immediate practical offspring, the breeding of better, more valuable plants and animals. Various breeding specialists in the Department of Agriculture contribute chapters on such things as improvement in wheat, corn, flax, tobacco, swine, mules, poultry, and so on. The treatise is explained in terms which the average practical man can understand and apply to his own practical problems.

The same fat volume includes the annual report of the Secretary of Agriculture, segregated from the scientific matter in the larger portion of the book, where the reader may either take its doctrines or leave them.—$1.25. Purchase direct from the Government Printing Office, Washington, D. C.—*A. G. I.*

THERMIONIC EMISSION

By T. J. Jones, M.Sc.

COMPLETE understanding of the operation of vacuum tubes, either by the engineer concerned with their development or by the layman who likes to dig into a subject and find the real meat of it, depends largely upon an appreciation of the part played by the emission of electrons under varying conditions. The present book, pocket size, gives in compact form comprehensive data covering the subject. An excellent bibliography is included. An understanding of advanced mathematics is desirable.—$1.35 postpaid.—*A. P. P.*

OLD WIRES AND NEW WAVES

By Alvin F. Harlow

HISTORIES are seldom interesting, but here is one on communication in all its branches that holds the reader's interest from start to finish. Beginning with the signal fires and other crude devices of the ancients, it carries the theme of rapid communication up to the present moment, including facsimile and television. No mere recording of events as they happen, the book is made doubly interesting by the style in which it is written. The author has, without marring in the least the authenticity of his work, managed to inject a degree of humor and reader appeal that is unusual in a book of this kind. Fathers (and mothers) will enjoy this running story; high-school youngsters will then get a chance at it and will absorb knowledge painlessly while being entertained. All the facts are backed by sound authority. Well illustrated; 548 pages.—$5.20 postpaid. —*A. P. P.*

ELEMENTS OF OPTICS

By Joseph Valasek, Ph.D., Assoc. Prof. Physics, University of Minnesota

NOT a new book, but the second edition of an older one which was revised in 1932. Because there has been some call for a short textbook on optics it is reviewed here now. In 230 pages the author succinctly covers light and its propagation, photometry, velocity of light, wave theory, reflection, refraction, lenses (aberrations), optical instruments, color, interference, diffraction, double refraction and polarization, radiation, relativity, the nature of light. This is a beginning textbook for a three-month college course, and is for those who have had some physics, also geometry, algebra, and trigonometry. Being short and compact it will require close study.—$2.40 postpaid.—*A. G. I.*

ROMEO AND JULIET

The Play and the Complete Screen Script

IF you have seen, or expect to see, the motion picture "Romeo and Juliet," you will want to read this book. It gives the original Shakespearean text of the play, the actual shooting script of the screen version, and articles and notes on the technical problems involved in putting this ever-popular play on the screen. The side-by-side placement of the text and the script shows how faithfully, in this one instance, the producers have followed the original, leaving out much of the "hokum" that too often characterizes Hollywood's attempts to put classics on film. Illustrated.—$2.20 postpaid.—*A. P. P.*

Junior Scientists' Selection

AMONG the welter of new books for children this year, there are a number of excellent ones for the Junior Scientists. Most of those mentioned briefly below are for the ages of six or eight to fourteen; contain interesting facts presented in easily readable fashion; are well illustrated; and will make splendid Christmas gifts from the elders who read this page.

HOME CARPENTRY, *by Edwin T. Hamilton*, contains over 100 different articles, ranging from book cases to bed-tables for the amateur craftsman, and includes 200 illustrations and plans.—$3.20 postpaid. . . . OUR NAVY, *by Charles J. Finger*, gives an outline history of this important branch of our national defense (ages 10 to 14).—$2.15 postpaid. . . . THE BOOK OF LIVING REPTILES, *by Raymond L. Ditmars*, famous curator of the New York Zoo, *and Helene Carter*; all about crocodiles, alligators, snakes, turtles, and lizards—where and how these strange creatures live.—$2.15 postpaid. . . . THE DIRIGIBLE BOOK, *by William Clayton Pryor and Helen Sloman Pryor*. A splendid book of photographs of large and small airships, inside and out, with a story about Bill and Ann. Includes pictures of the new German *Hindenburg*, taken on her maiden voyage.—$1.15 postpaid. . . . DO YOU KNOW ABOUT FISHES?, *by Janet Smalley*, a new picture book in four colors and black-and-white, by the Philadelphia artist-author who has been so successful in making facts exciting for little children.—$1.40 postpaid. . . . WIGWAM AND WARPATH, *by Juergens-Lichtie*. By means of text and 100 illustrations, the youthful reader learns how the Indians lived.—$1.15 postpaid. . . . FAMOUS AMERICAN TRAINS AND THEIR STORIES, *by Roger Reynolds*. Dramatic stories of the best-known American trains—how they got their names, what rivers, mountains, deserts they cross.—$1.15 postpaid. . . . LET'S GO 'ROUND THE WORLD WITH BOB AND BETTY, *by Phyllis Ayer Sower*. Through the Panama Canal, across the Pacific and around the world! Many new things to see at all the fascinating ports. —$1.15 postpaid. . . . MIGHTY ENGINEERING FEATS, *by Harriet Salt*. An authentic book for young people 14 and over. Vividly and authoritatively discusses 10 of the mightiest engineering feats which have gone into the making of our country. Photographs and line drawings.—$2.70 postpaid. . . . MORE SONGS OF WILD BIRDS, *by Albert R. Brand*. Three double phonograph records made direct from nature are included with this volume, which is a guide to bird song for boys and girls of all ages.—$2.65 postpaid. . . . THE BOYS' BOOK OF MODEL AEROPLANES, *by Francis A. Collins*. This is the Third Revised Edition of a book which will interest the future airplane pilot who likes to make things.—$2.15 postpaid.

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A Neolithic Cook, 9000 Years or So Ago, Cracked his Gourd Stew-Pot. Then He Invented Pottery

IN a constant effort to improve the quality of American-made motor cars, research engineers are continually investigating new materials and designs. An example of this work is shown in the photograph reproduced on our front cover, taken in the General Motors laboratories. Here a stroboscopic set-up is being used to study gear tooth contact in an automobile differential assembly. At the same time one of the engineers is using a sensitive stethoscope in order to detect sounds that might indicate approaching trouble.

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50 Years Ago in . . .

Scientific American

(Condensed From Issues of December, 1886)

SPEED—"On Nov. 16 a Michigan Central train on the Canada Southern division, having on board a number of directors and officials, ran from St. Clair Junction to Windsor Dock, a distance of 107 miles, in ninety-five minutes, being at the rate of over sixty-seven and a quarter miles per hour."

TUNNEL—"The work on the new lake tunnel at Chicago is progressing rapidly. The men work in three shifts, of eight hours each. The first digs the hole about 10 ft. in diameter, through clay, at the rate of about 18 ft. per day, the second trims it up and walls with planks, and the third lays a circular wall of bricks in cement, 12 in. thick. The tunnel is left a shade over 7 ft. in diameter, the whole plastered with cement."

SUBMARINE—"A small vessel that has attracted much attention during the last few months is a submarine boat designed for use in placing torpedoes under the bottoms of war vessels. The *Peacemaker* is thirty feet long, seven and a half feet wide and six feet deep. The present craft is provided with a small sighting dome, nearly amidships, and projecting fourteen inches or more above its deck. A central fin extending the length of her deck, and rising about as high as the pilot's dome [is] designed to act as a fender. The great difficulty in submarine navigation has been to obtain an available source of power. In the *Peacemaker*, the Honigman soda boiler is used. A fourteen horse-power Westinghouse engine is used to drive the screw. . . . Her deck is to be provided with torpedo gear for discharging floating torpedoes . . . provided with cork floats, and electro-magnets, and electric detonators. . . . The instant they come in contact with the iron bottom of a war vessel, they will adhere with great tenacity."

PARIS CEMENT—"A new cement, called 'cement de Paris,' has been introduced in France. The material is stated to be at least equal, if not superior, in quality to the English article. This material is said to possess durability and the cold appearance of marble, and a wall rendered, floated, and set with it becomes impermeable to moisture."

SHALLOW—"A steamboat has been built to navigate the Allegheny River between Pittsburgh and Kittaning, a distance of 45 miles. Although 142 ft. long and 25 ft. beam, she draws but 10 in. of water. There must be many streams navigable for steamers of light draught like the above. It only requires a little enterprise to make them available."

COLOSSAL—"The existence of the great statues of Bamian has been long known to Indian archaeologists, but reliable measurements have never been brought home till now. There are five statues at Bamian; three of them are in niches, which have been cut out, the figures being formed of the rock within the niche. The largest statue is 173 ft. high."

SLAG—"A new industry has been started in Middlesbrough, Eng., the object of which is to utilize blast furnace slag. . . . It has been found that if slag which has been annealed be pulverized, and mixed with cement in certain proportions, and pressed into moulds, and put aside for, say, three months, it sets into a peculiarly firm, hard, and solid mass. The value of these qualities was soon perceived, especially as applied to the manufacture of concrete flagstones."

TRACTOR—"The endless tracks are composed mainly of anti-friction rollers, united by links to form an endless chain. The side pieces of the body of the vehicle are oblong in form, are held parallel with each other by suitable framework, and are flanged to form guides for the wheels of the endless tracks, so that all danger of lateral displacement of the tracks is obviated. The guards surrounding the wheels are made up of links of sheet metal . . . hinged together to form a continuous chain to inclose the wheels. As the vehicle is drawn along the ground, the contact of the endless guards with the ground will cause the body to be drawn along the endless tracks."

AIR MAIL(?)—"Mr. Preece states that in some of the British post offices a great deal more air power than electrical power is used. In London, Manchester, Liverpool, and Glasgow, all the telegrams were transmitted by air power, and the use of air pressure for that purpose had been applied for thirty years."

STEAM TRICYCLE—"Mr. Louis Lallemand, a skillful mechanic of Vassy, has just constructed a steam tricycle, to be heated by petroleum. . . . The consumption is about three and a half pints of petroleum per hour. Upon a good road, a speed of from 7 to 9 miles per hour may be obtained."

NAVY—"The condition of the navy is attracting more attention than it has received at any previous time since the close of the war. Naval officers and a few legislators have long known—and the fact is now generally admitted by the press and the people—that we have not had during the last twenty years a single sea-going ship that would have had a hope of victory if pitted against any of the first class warships of other nations launched during that time."

WAGES—"Hon. Abram S. Hewitt, our new mayor-elect, says that 'for the first time in the history of this country, the day's wages of a mechanic can buy a barrel of flour.'"

STRIDE—"Dr. Gilles de la Tourette has found, from a comparison of a large number of cases, that the average length of a pace is, for men, 25 inches; for women, 20 inches. The step with the right foot is somewhat longer than that with the left."

PATENTS—"The question is sometimes asked why it is that the examiners of the Patent Office are so liberal in the allowance of patents, especially in simple things. The answer is obvious. It is clearly their duty, under the law, to exercise the greatest degree of liberality toward the inventor, and to do everything in their power to facilitate him in securing his invention by patent. The inventor is a man who supplies the country with new and valuable forms of industry; he supplies the people with all manner of comforts and conveniences. . . . Doubt should in every case be resolved in the inventor's favor."

AND NOW FOR THE FUTURE

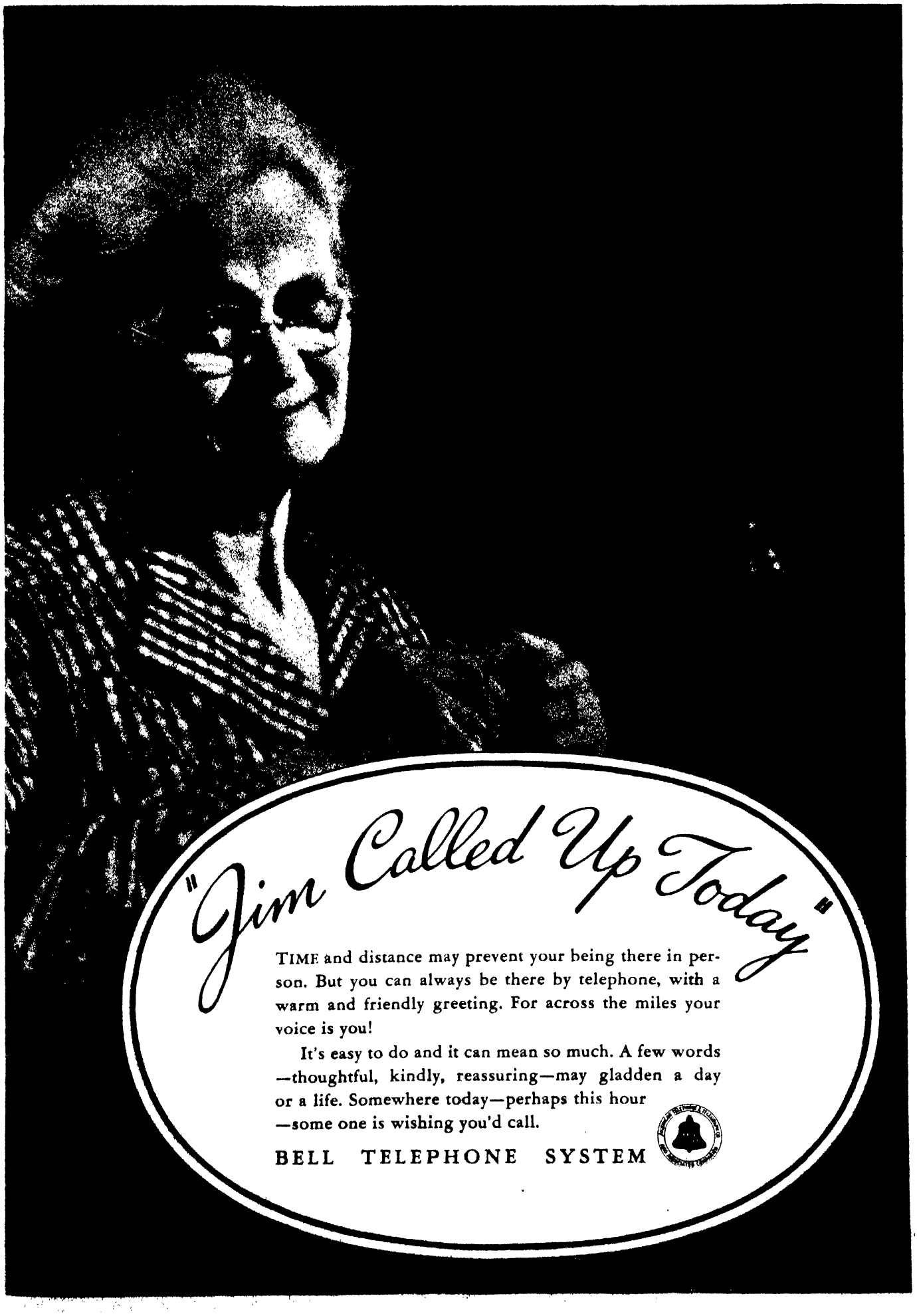
¶Big Engineering by Hand Labor in China

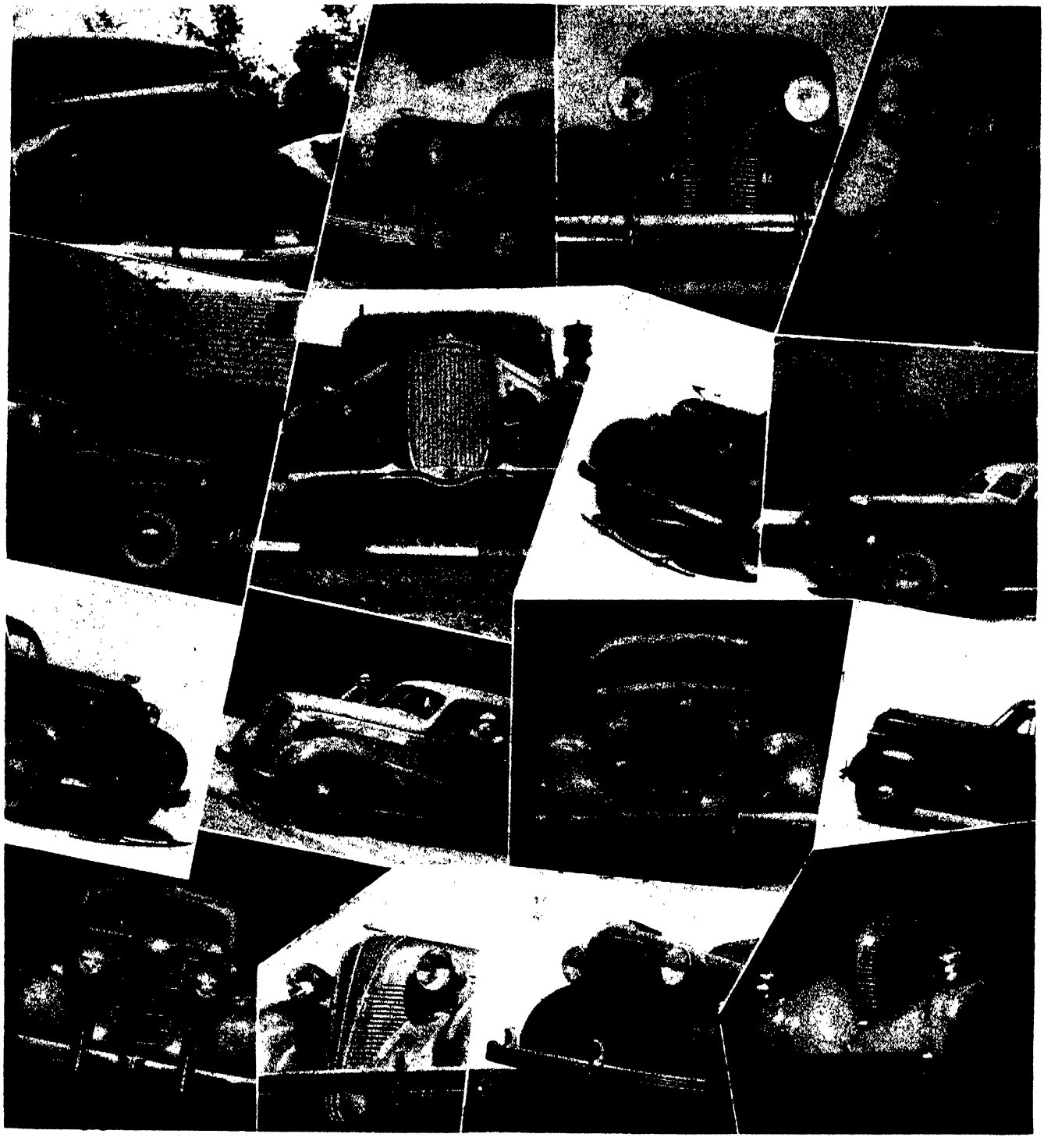
¶Color in Movie Cartoons, by Andrew R. Boone

¶Fish and Physicians, by Henry Pelham Robbins

¶Broiler Factories (and Eggs, too), by Philip H. Smith

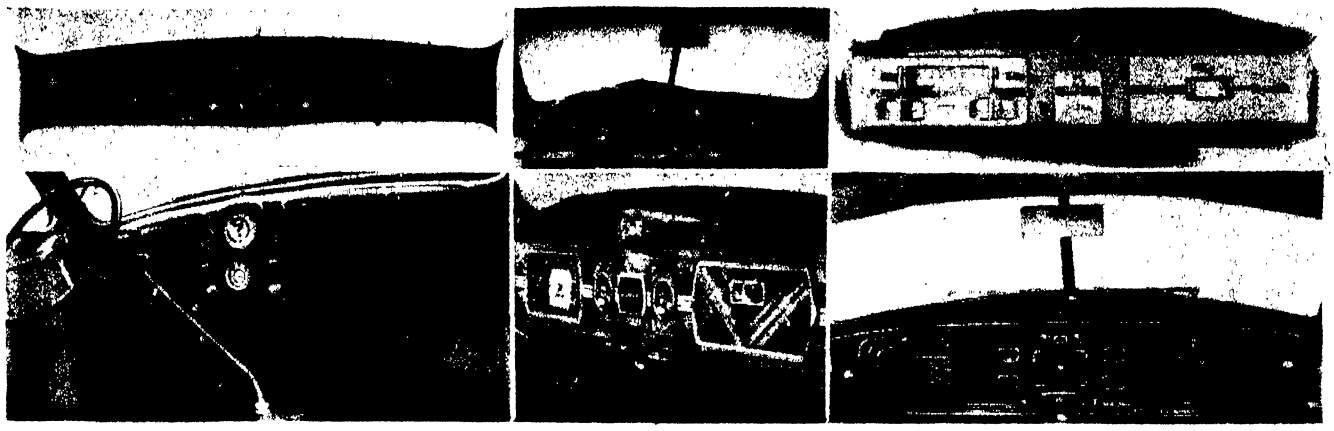
¶Ourselves and the Feeble-minded, by G. H. Estabrooks


"Jim Called Up Today"
TIME and distance may prevent your being there in person. But you can always be there by telephone, with a warm and friendly greeting. For across the miles your voice is you!
It's easy to do and it can mean so much. A few words —thoughtful, kindly, reassuring—may gladden a day or a life. Somewhere today—perhaps this hour —some one is wishing you'd call.
BELL TELEPHONE SYSTEM



KNOW THEM BY THEIR FRONT ENDS

TYPICAL of the 1937 automobiles are the representative cars illustrated above. *From left to right, top row:* Lincoln "Zephyr"; De Soto; Dodge; Studebaker. *Second row:* Buick; Pierce Arrow; La Salle; Cord. *Third row:* Cadillac; Chevrolet; Oldsmobile Six; Pontiac. *Bottom row:* Oldsmobile Eight; Terraplane; Chrysler "Royal"; Willys. Many of the new features incorporated in these and other American automobiles for the coming year are described and illustrated in detail in the article starting on the opposite page. An intensive survey of the entire motor-car field shows that, while there is only one wholly new car on the market for 1937, there have been numerous refinements and developments in previous models, all of which contribute toward safety, comfort, or economy for the automobile purchaser.



What you see as you drive them: Instrument panels on *(upper row, left to right)* Buick, Chevrolet, Studebaker, *(lower row, left to right)* Lincoln "Zephyr," Dodge (note recessed controls and ignition switch mentioned in article), and Hudson

Your 1937 Motor Car

Engineered for Safety . . . Improvements in Minor but Important Details . . . Lowered Center of Gravity . . . "More Car" for Your Money

By A. P. PECK

IN order to present to our readers the latest possible information on the new motor cars, the writer of the accompanying article, one of the editors of Scientific American, spent several days visiting the factories in and around Detroit. He has purposely avoided dwelling on those phases of motor car design which are ordinarily heralded widely through advertisements; rather his aim has been to uncover those minor but important developments which are not usually well known, but which contribute largely to the comfort and satisfaction of motoring. —*The Editor.*

RESEARCH in a hospital may seem to be a queer approach to solving motor-car problems, but it is exactly what has been done in designing some of the motor cars that will be available by the time this article is in print. Realizing that many of the injuries suffered in motor car accidents are caused by drivers or passengers being forcefully thrown against projections on automobile dashboards, Chrysler engineers took up the matter with hospitals and doctors throughout the country in an endeavor to determine just how serious this phase of the accident problem really is. The result is that the instruments of the entire line developed by them are set flush with the dashboard; there are no projections—not even light control switches—against which the driver or passengers can be injured. Even the ignition key is inserted in its lock in a miniature tunnel at the lower edge of the dash, so that it does not project at all. Light switches, hand throttle, and other manual controls are also at the lower edge, from which position they are operated by a finger tip hooked into a notch.

Curved door handles on most 1937 cars are an added safety feature

Door handles, inside and out, are so curved that they cannot catch clothing or pierce flesh.

The foregoing is typical of the attention which is being given in increasing degree to the safety of motorists. Minor in scope as it may seem to be, it indicates that manufacturers are acutely aware of the necessity of inbuilt safety in cars, and are striving to do everything possible to decrease motor driving accidents.

Presenting an impartial analysis of the new features of the 1937 motor cars involves peculiar difficulties. The greatest progress lies in development and improvement of existing parts and mechanisms, with little that can definitely be labeled as "new" in the strictest sense of the word. If, therefore, the present article seems to dwell on the smaller details, it must be realized that these are just as important to the motorist as radical changes in design or construction—more so, in fact, since such progress is indicative of the lessons that are being learned by experience and of the application of this knowledge to the construction of better cars for the public. The accompanying photographs and explanatory notes tell much of the story of the 1937 cars; the following paragraphs supplement the photographs and describe some of the details that

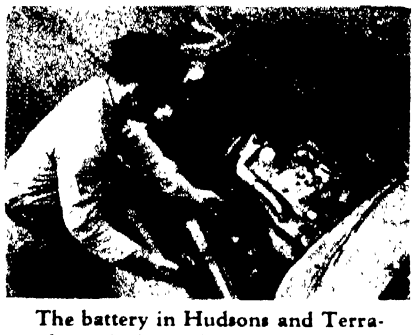
Front compartment in a Pontiac, showing radio, heater, and speaker

Capacious trunks are the rule on the cars for 1937. At the left is Chrysler "Royal" touring sedan, at the right the Pontiac touring sedan, and below, the Lincoln "Zephyr." Note how the spare tire in this model is mounted on a rack that swings down out of the way, giving complete access to the large luggage compartment

do not lend themselves to photography.

In order to simplify the servicing of cars when the driver pulls up for gas, oil, and water, some of the designs—Chevrolet for example—place all the intakes for these essential fluids on the right side of the car. No longer need the attendant hop from one side of the car to the other in fulfilling his duties. Up comes the hood; there are the water and oil filler caps. This part taken care of, the attendant fills the gasoline tank without walking around the car. This is a small factor, perhaps, but one that adds to convenience.

A feature that practically all manufacturers have considered this year is prevention of fog and frost formation on the windshield. The recent development of hot-water heaters for car interiors has been in their favor. Most of the new cars are provided with means for taking off a stream of hot air from the heater and directing it upward



The battery in Hudsons and Terraplanes is located under the hood. It is kept cool by a flow of air

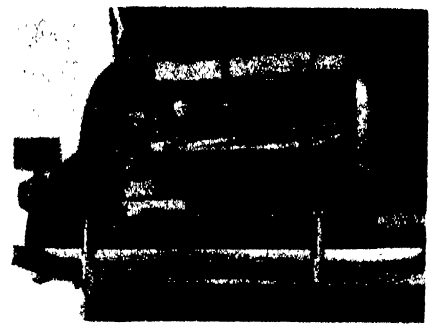
against the inside of the windshield. This evaporates interior mist, and in cold weather warms the glass so that frost cannot form on the exterior and the windshield wiper can do its job regardless of outside temperatures.

In the matter of wheel construction, it is evident that wire wheels are definitely out of the picture, as far as mass production is concerned. Pressed steel artillery and disk wheels are far in the majority. Although disks seemed to have been eliminated years ago, the increased use of "doughnut" and "air wheel" tires, with the decreased wheel

size accordingly necessary, has brought the disks back to some prominence, sharing the field with pressed steel artillery wheels with very short spokes.

Probably the most interesting development for 1937 is the advent of the new Willys. Whether this entirely new car will stand the gaff of usage is not for us to say; only time and hundreds of thousands of miles of driving can answer the question. Nevertheless, a newcomer to the field, even though it has an old and well-known name, is always welcome and provides material for speculation as to performance and durability. The new Willys is announced as the lowest priced car in the standard size field. Its body is a fine piece of design—modernistic to a large degree, but pleasing even to those eyes which usually belittle the modern trend. At the time of writing no mechanical details are available except that the engine will develop 48 horsepower at 3200 revolutions per minute, and the valves seat on ring inserts that resist pitting and reduce the necessity for frequent valve grindings—a type of construction now widely used.

With increased use of all-steel bodies it has been necessary to devote not a little attention to the problems of noise. All new General Motors cars have bodies that contain a minimum of wood, and clever design has been applied to reduce road and body noises to a low value by means of proper placement of insulating materials. Chrysler engineers, who were among the first to pioneer in the use of all-steel bodies, have produced a rubber mounting for bodies that eliminates all metal-to-metal contact and results in the body literally floating on rubber. This is accomplished by the use



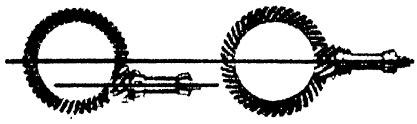
of a number of brackets rigidly riveted to the chassis frame, each carrying three-piece rubber inserts on which the body rests. Body bolts go through these rubber inserts and are drawn up to a predetermined tension that is limited by a metal tube running through the rubber insert. Thus the rubber is under a constant but comparatively light pressure at all times and effectively insulates the body from road noises.

Road noise is not the only noise bugaboo of all-steel bodies. Vibration of metal panels, regardless of how well braced they may be, contributes its share. This has been kept under control by the liberal use of insulating and sound deadening materials. For example, the metal floor panels of the De Soto and other cars made by the same company are covered with a half-inch thick coat of asphaltic compound that is bonded securely by heat treatment. This, together with the conventional floor rugs, effectively eliminates vibration. The interior surfaces of the metal roof and side panels are treated by spraying with a similar material, inserting sheets of

Torque arms, mounted in rubber on all new Packards, hold the independently sprung front wheels in rigid alinement against road shock

sound-damping fabrics, and covering all with the usual upholstery. Speaking of upholstery; an added safety feature is found in the rolled back of the front seat in certain body styles of Dodge cars. The soft cushion thus formed serves to lessen the effect if a back-seat passenger be forcefully thrown against the front seat in the event of a sudden stop or collision.

New shock absorbers are adding their part to riding comfort. Many of the 1937 cars are using shock-absorbers of the so-called airplane type. These require no linkage as did older models; they are long and comparatively thin telescoping tubes that are fastened directly to axles and body, thus providing less chance for squeaks and rattles to creep



in as the parts wear with use. These shock absorbers are all hydraulic in action.

In the power plants of many of the new cars, aluminum pistons are found, but they are by no means the aluminum pistons of a few years ago. By an electrolytic process they are "anodized" to produce a file-hard surface that resists wear. Some of them are skirted and some have new shapes designed to give better service and faster acceleration. Full-length water jackets serve to cool motors more efficiently and also to keep the oil in the crankcase at a lower temperature.

The Buick oil pump operates in conjunction with a floating screen and inlet, so that the oil forced through the engine is always drawn from the top of the oil supply in the crankcase, and therefore cannot carry with it any sludge or dirt that may have accumulated.

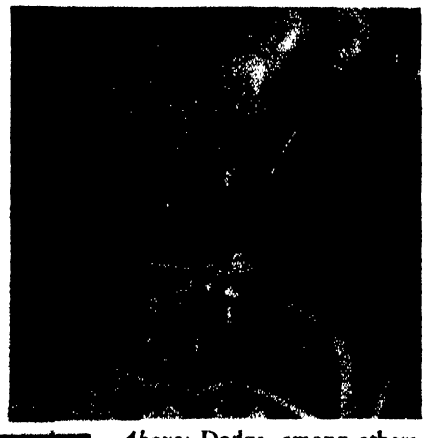
VENTILATED clutches in Plymouth and other Chrysler-made cars give promise of longer life and better action. While the car is in operation, air is constantly circulated around the clutch members, keeping them cool and hence increasing their efficiency.

Although free-wheeling, so widely acclaimed only a few years ago, has been

Two methods are in general use for lowering the height of the drive shaft and permitting lower body mounting. One is the hypoid rear end, below and at left. In the drawing are shown the relative heights of the drive shaft with hypoid and pinion gears. The other method, as in Oldsmobile, is shown at the right, where a two-piece propeller shaft is employed

abandoned by many manufacturers, Hudson and Terraplane still retain it in the form of a modified automatic clutch for use with their "Electric Hand" gear-shifting mechanism. Since, however, it is usually undesirable to use free-wheeling over 20 miles an hour, a governing device has been installed to limit the free-wheeling action to speeds of 15 miles an hour and less. Studebaker, one of the first advocates of free-wheeling, also has a modified form for use in connection with their overdrive. The over-running clutch operates only temporarily when the overdrive is coming into or going out of use. The car coasts against engine compression in all speeds.

A "hydraulic hill hold" is available on Hudsons and Terraplanes, by means of which the car is prevented from

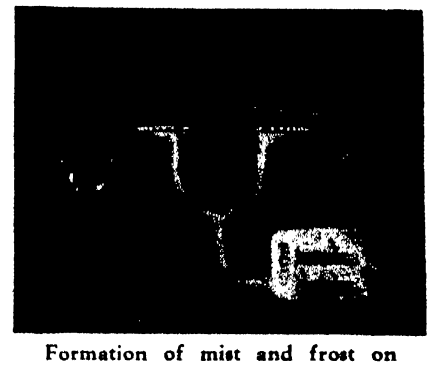


Above: **Dodge, among others, cools the fuel pump and filter by a current of air directed by a curved metal deflecting plate**

Left: **The new Willys, with standard tread, appears in 1937 as a wholly new car with modernized yet pleasing lines**

backing up when stopped on a hill. This device is actuated by the same fluid used in the braking system, and operates in conjunction with the clutch so that the car is held by the brakes until the driver operates the clutch to start the car forward.

Lowering the center of gravity of a motor car—highly desirable for safety, better roadability, and more comfortable riding—is largely limited by the matter of transmitting power from the engine via a drive shaft to the differential. Common practice in the past has been to lower the body around the drive shaft by providing a tunnel in the flooring. This, however, is an undesirable make-shift and has given way to two general types of improved methods

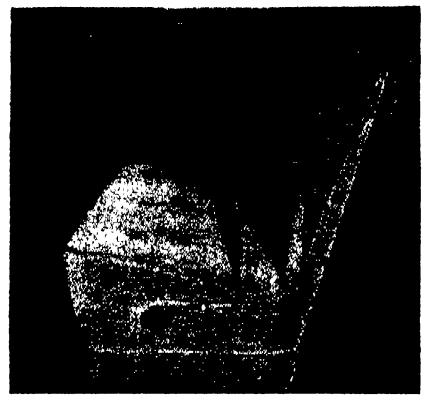


Formation of mist and frost on windshields is prevented by blowing air from the heater against the glass

of power transmission. Most widely used in 1937 cars is the hypoid gearing in the differential. By means of a design that is half-way between a worm gear and the conventional pinion, the hypoid on the end of the drive or propeller shaft is located lower on the ring gear than would be possible with an ordinary pinion. This permits a lower position of the drive shaft and hence a lower body without a tunnel. The other method of achieving the same end is to use a two-piece propeller shaft as is done by Pontiac. In this design the forward half of the shaft is integral with and supported by the transmission. Connecting this shaft with the differential is a second shaft with universal joints at each end.

Typical of advances in driver and passenger comfort are the changes in seat design that are so noticeable in the new models. In every case the seats

Typical of new telescoping shock absorbers is that used by Dodge



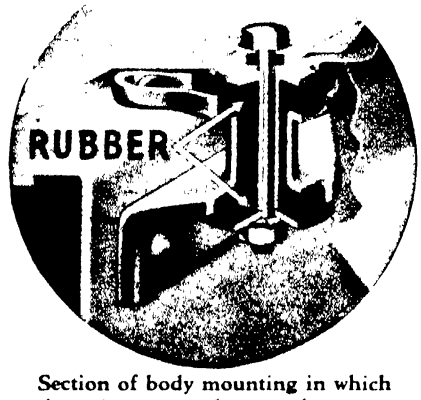
Adjustable seat in which angle of back changes, as in the Chevrolet

Ventilated clutches are used in all of the Chrysler Motors cars

and backs have been so constructed that they hold the body in a natural position—not reclining with legs thrust forward nor sitting bolt upright as in a hard straight chair, but much the same as when sitting in a well-upholstered easy chair. Driver's seats are universally adjustable, and most of them incorporate a new feature of tilting slightly forward as they are moved nearer to the steering wheel. Thus a short-legged driver is given as comfortable a position as one of more normal stature; the same is true for long-legged ones.

A FEATURE that the buying public cannot see on many of the new 1937 cars, but one that is of great importance to lengthened car life, is that all sheet metal is rust-proofed before it is enameled or lacquered. All bolts, nuts, washers, and so on are cadmium plated to prevent rusting.

A trend that has been evident in motor-car design during the past few years, and which is even more noticeable for 1937, is the redistribution of weight and the relocation of passenger position. Hand-in-hand has gone a development of better braking systems. In



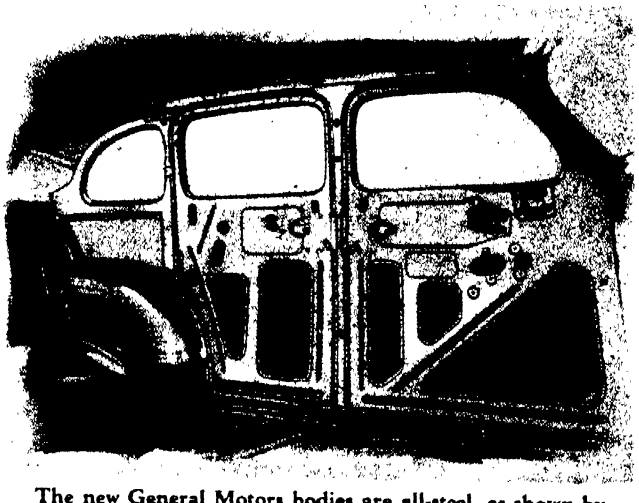
Section of body mounting in which there is no metal-to-metal contact

Rolled back of the front seat forms a cushion—safety for passengers

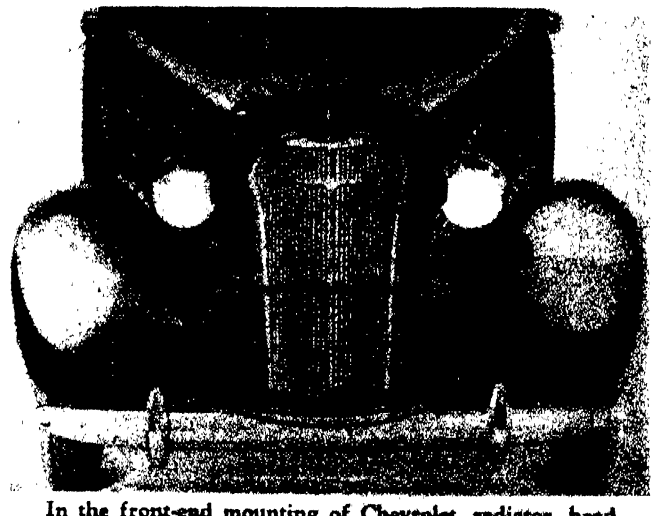
many of the new cars, 50 percent of the total weight of the car, exclusive of wheels and axles, is carried by the front wheels, and 50 percent by the rear wheels. Also, rear-seat passengers are placed farther forward. These two developments have definite implications for safety and riding comfort. It is now possible to apply more braking power to the front wheels and thus achieve easier stopping in an emergency by taking advantage of the forward shift of the center of gravity as the brakes are applied and the car slows down.

Up to the day of going to press, the Ford organization was unable to supply the writer with details of the changes and improvements being made in their new cars.

TAKEN as a whole, the outlook for the purchaser of a 1937 car is bright. He will get more for his money than ever before in safety, comfort, quality, fine appearance, service, and economy. That the ultimate in motor cars has not been reached is obvious; there is still a long way to go, but what the motor car of the future will be even the best informed engineers hesitate to predict.



The new General Motors bodies are all-steel, as shown by this photograph of the interior of a partly assembled body



In the front-end mounting of Chevrolet, radiator, headlights, and sheet metal are formed into a single structure

OUR POINT OF VIEW

Future Motor Cars

AS stated in the article ending on the opposite page, even the best-informed engineers in the motor-car industry hesitate to say what the future holds for the automobile. One such engineer, recently interviewed, ventured the prediction that the next big change will be in power plants. Pressed for details, he stated definitely that it would not be in the direction of the Diesel, but would go no further than to venture that it would involve a complete redesign of the automobile engine and body as we know them today. One of the truths with which the motor-car designer is faced is that the power plant in the modern car takes up too great a percentage of the space in the car. Roughly one third of the wheel-base is occupied by the engine, the rest by the passenger and baggage compartments. What to do about this state of affairs is a problem that is receiving considerable but unpublicized attention in the research laboratories of many of the motor-car manufacturers.

Thus the way is left open for a little stimulating theorizing. If the power plant can be made smaller, more compact, and still with the required horsepower for present-day traffic demands, cars can be made shorter, more compact, easier to handle and park. More cars can be driven on a given stretch of highway with no increase in congestion, and if they can be more easily maneuvered, the chances of accidents will be reduced. With this in mind, two thoughts emerge: radial engines such as used in aircraft, and engines in the rear. Why not combine the two? A radial air-cooled engine, placed in the rear and cooled by air conducted through ducts from the front of the car offers a starting point for solving the problem. "Bugs" will be present aplenty, but surely not formidable enough to halt progress, if this be a feasible way of gaining a desirable end.

Such theorizing is a pleasant recreation and harmless, but it is brought to an abrupt end by a realization of one factor that is neither mechanical nor technical. This factor is the human resistance to radical change. Courageous indeed must be the motor-car manufacturer who will attempt to give the public something in motor cars that is radically different from the cars which that convention-bound public is used to seeing. Courageous—and, even more important, backed by unlimited finances to take the losses that will inevitably result.

The never-ceasing efforts of the research engineers give assurance that changes will be made in motor cars, changes that will react to the benefit of the public as well as to the manufacturers. When research uncovers ways and means of making radical changes in automobile power plants, past experience with a fickle public will undoubtedly serve as a guide post which will point the way toward introducing the change with the least possible resistance. Through a process of evolution extending over a period of years, subtle changes in body design will undoubtedly be made, paving the way for an entirely new concept in motor-car construction. Then, just as the clothes of the last decade appear ridiculous today, today's motor-car design will be seen in its true light as being only a step removed from the horse and buggy.

Unclean!

THE recent escape of 235 lepers from an institution in Manila points directly at the folly of premature announcements of "cures" for serious diseases. Incited by legislative action that would have ended segregation of lepers if Governor General Frank Murphy had not vetoed it, these unfortunate victims of the disease gained the idea that they need no longer be kept from contact with the outside world. Despite a growing belief among medical men that leprosy can be cured and that it is not contagious, there is not as yet basis enough in fact to warrant discontinuance of segregation. Such beliefs should be kept within the profession until satisfactory proof has been reached.

Ship Personnel

THE problem of advancing safety at sea has been more vigorously attacked in this country in the last decade than during any previous ten-year period. Progress has been made, but much still remains to be done. There is, for example, the question of qualifications of personnel. Discussing this phase recently, Captain J. H. Tomb, U. S. N. (retired), said that minimum requirements for men qualifying as able-bodied seamen are "a travesty on safety at sea."

An American seaman, according to Captain Tomb, superintendent of the New York State Merchant Marine Academy, becomes in three years by Act of Congress, an A. B. even though he has "damned little training in the fundamentals of his trade. . . ." Yet the graduate of a state marine school is prevented by Act of Congress from getting his A. B. ticket until one year after graduation, although he is qualified to hold a licence as a third mate. The result of this peculiar situation has been that many people have criticized American seamen as inefficient; we have come to depend more and more on alien seamen to man our ships, and safety at sea has suffered.

Captain Tomb urges establishment of a national merchant marine academy; or as an alternative, that nautical training be extended to high schools, apparently as an elective vocational course. He estimates that this subject is of interest to "at least one third of all American boys."

For a different reason but to the same end, Joseph B. Weaver, Director of the Bureau of Steamboat Inspection Service of the Department of Commerce, had previously urged the establishment of a series of training schools for seamen. It is his belief that the *Leviathan*, now retired and tied up to a pier, should be converted into a training ship for seamen who desire advancement. "These men should be encouraged to study," he says, "and we should provide facilities for their training." The *Leviathan*, moored at New York, could accommodate 1000 seamen as could also the old *America* if she were stationed at San Francisco and the old *George Washington* if at New Orleans. The courses could last three or four months and the cost would be low. His plan, Mr. Weaver explained, would save three discarded ships from ruin, provide employment during their remodelling, and improve the quality of man power in the merchant marine.

Here are two really constructive ideas. One seems to envision preliminary nautical education while the other concerns advanced training. Both may be unsound in certain aspects but both do possess the merit of approaching boldly the problem of safety at sea as it pertains to personnel. And this, we believe, is vital. It is vital because lives and property are at stake; the men that man our ships are the "human factor." In view of the steadily mounting number of criticisms against that human factor that have been heard recently, isn't it time something were done about it? We are sure of it. And Congress should get busy.

British "Mosquito Boats"

New Type Warship . . . 60 Feet Long . . . 40 Knots . . . Habitable, Seaworthy, Efficient . . . Long Distance Raiders . . . Torpedoes, Guns, Depth Bombs

By OSCAR PARKES

WHEN King Edward took the helm of *M.T.B. No. 1* and ran her out of Portsmouth harbor and around Spithead on June 30, the occasion was one which is likely to rank as a naval event in years to come, as it signifies the advent of a new type of warship into the British Navy—the motor torpedo boat.

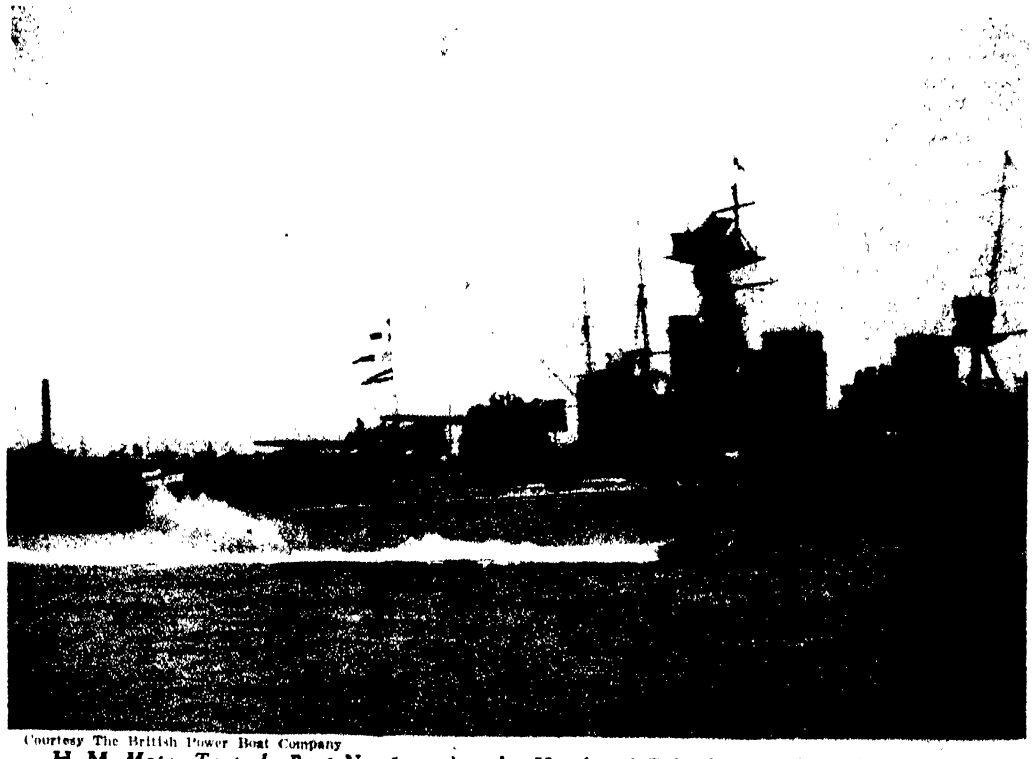
At first sight there may not seem to be much difference between a motor torpedo boat and the coastal motor boats and submarine chasers such as are found in most navies; actually there is every difference.

The C.M.B., as originated by Thornycrofts, was a war-time production designed for fast, short-distance raiding, a surface-skimming, frail little craft which bounced along the sea when weather permitted, and was a hard-riding, uncomfortable craft at 40 knots which had a human fatigue time of about two to two and one half hours. The 55 footers weighed 10 tons and naturally were very lightly built. Their progress was such that control was difficult; no compass could give a course to a boat which bucked like an unsprung car at high speed on a rough road. Lewis guns were carried but it was impossible to use them effectively. A couple of 18-inch torpedoes were carried in troughs and discharged, nose forward, over the stern when the boat was in a line with her target. To avoid being hit herself, she was instantly slewed round and steered clear, so that torpedo attack was a somewhat tricky business demanding a clear brain and quick judgment.

WITH the exception of the latest German boats, all the fast motor boats now built are based on the C.M.B's. with very shallow draught, light displacement, and no attempt at habitability. Some of the French craft can do their 50 knots, but such speed has little war value because the boats themselves have such limited possibilities. The other type of heavier motor boat, like the British M.L's. and the United States S.C. boats with a speed of below 20 knots, belong to a different category and are quite unsuitable for torpedo operations requiring high speed, although they are quite efficient as patrol boats and chasers. The M.T.B's. are a completely new proposition, at least so far as the British Navy is concerned. To some extent the Germans may have anticipated them in their *S.1—S.15* types, but without full data no definite opinion can be expressed on this point. Designed by H. Scott-Payne of the Motor Boat Trophy fame, and built by his firm, the British Power Boat Company, the M.T.B's. are intended for long distance, deep-sea work as independent units, and it is anticipated that they will commence a new phase in torpedo warfare.

We have seen the torpedo boat, starting off with the little steam launches fitted with a spar torpedo which Yarrows built in 1873, and the first boats built to carry the Whitehead torpedo which the firm supplied to the Argentine Government a year or so later, grow up in size and power from the first destroyers of 250 tons designed by Yarrows in 1892 to the super-destroyers like the French *Fantasque* class of 2500 tons which have entered the cruiser category both in tonnage and gun-power. Cost and size limit the numbers of such craft which have completely outgrown economical standards and, when a cycle of evolution has been made, it is only natural that the reversion should be made to the smallest size consistent with functional ability. Hence, with the advent of the M.T.B., we are back again to the sea-going torpedo boat, a boat cheap enough to be built in large numbers, fast enough to make her objective and avoid destruction, and armed with torpedoes which can menace a modern battleship.

In the old days, we had first- and second-class boats, the latter being small enough to be transported in depot ships and to form part of the equipment of the battleships. Thus, when Lord Fisher was captain of the *Inflexible* in the



Courtesy The British Power Boat Company

H. M. *Motor Torpedo Boat No. 1* passing the *Hood* and *Effingham*. A fleet of these boats could be built within the cost of the *Hood*, and at times might do more effective work

A close-up of the first *M.T.B.* at speed showing about as much as can be learned of hull design. Her clean lines and absence of parasite structures favor attainment of high speed

'Eighties he used to say that he would deal with opposing battleships by closing them at nightfall and lowering his second-class torpedo boats for a mass attack. Nowadays, we want modern editions of the old first-class boats, which we have found in the M.T.B.—able to stand up to bad weather, habitable, and efficient.

A GLANCE at the illustrations will show that a special feature of the boats is their high freeboard, upon which so much of the success of the design depends. The dimensions are still confidential and so are the under-water hull lines, so that the essential data cannot be discussed. The only figures available show their length to be 60 feet, which is a mean between the medium (55 feet) and large (70 feet) C.M.B's. But, although the hull is a light shell, it is divided into many water-tight compartments which give positive buoyancy even when to all intents and purposes the boat has been "totally destroyed."

To say that they are magnificent in bad weather is the simple truth, and their maneuvering abilities are such as have never been achieved in boat design before. Their directional stability is such that once put upon a course they can be left there in either a beam, ahead, or following sea; and the controls, operated from the wheelhouse, are finger-light. To appreciate what this means to the navigator and the bearing it may have when hazardous and nerve-wracking operations have to be performed, I may say that Mr. Scott-Payne drove one of these boats up the English Channel and North Sea from Southampton to Grimsby for 14 hours and from Grimsby back again for 10 hours at 36 knots—both non-stop runs in bad weather. And, in his own words: "I was at the helm the whole time without, I may assure you, any physical fatigue of any sort."

For armament, each M.T.B. carries two 18-inch torpedo tubes which can discharge their weapons by a novel method at present confidential, the gear being fool-proof in operation and the lightest as yet designed. In addition, there are several machine guns and depth charges so that the boats can be employed either as torpedo boats against fleet units when, with their close approach and exact torpedo aim, they should be very efficient, or as submarine chasers.

Considering the size of the boats, their general equipment is wonderfully complete, comprising everything requisite from a heavy ground anchor, sea anchor, and towing gear to an ice chest, electric fans, spacious wardroom six-feet high, lavatory compartments, radio telegraph and telephone, fireproof petrol stowage, and ventilation system. The chart house has full electrical equipment, chart tables, and navigating gear; the whole design, arrangement, and construction bristles with novelties of every description. The M.T.B's. carry three quarters of a ton of fresh water and provisions and gear for eight men and two officers for 14 days.

Their triple screws, driven by three, 500 b.h.p., Power Sea Lion, 12-cylinder, petrol engines, are capable of providing a speed of over 40 knots, with a thousand-mile radius at 25 knots.

At present, six boats are under construction or completed and six more are included in the current estimates for which the sum of 700,000 dollars has been provided, but this batch is considered to be purely experimental. They can be built quickly and cheaply, so are essentially suitable for emergency construction, while the design lends itself to further development if the present boats are not large enough or fast enough for other conceptions of their war-time uses.

The German boats which can be compared with them date from 1929 to 1936 and are numbered *S.1* to *S.15*. They are 92 feet long and displace from 45 to 50 tons, their profile being that of an exaggerated C.M.B. with a low freeboard aft, sheering up to the bows. There are three engines of the airplane type, petrol driven, each developing 1000 horsepower for speed work, and a single 100 horsepower engine for cruising. About 40 knots is reported to be the best figure so far achieved for the petrol boats; whether those which are Diesel-driven have done so well is not known. The torpedo armament is heavier than in the M.T.B's. as the two tubes discharge 20-inch weapons. Photographs show these to be on the forecastle, which suggests that the trim may be slightly altered when they have the tubes loaded. Twelve officers and men can be accommodated, but their habitability cannot be equal to that of the British boats.

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Dr. Parkes, who is best known for his long editorship of the annual "Jane's Fighting Ships," has, with the limited facts at his command, removed much of the mystery surrounding the new British fighting boats. From newspaper accounts, the impression had been gained that these were to be of defensive use primarily in restricted waters adjacent to the British Isles. On this basis, authoritative American naval opinion holds that, having used "mosquito boats," we want no more of them. The British M.T.B's., however, are offensive boats, powerful, speedy, long-distance raiders and, as such, may point the way to a recapitulation of naval needs the world over. Large fleets of them can be built at low cost, and destruction of one or a score of them in wartime would not compare in loss of men and materials with the loss of one battleship.—The Editor.

CHEMISTRY AND THE FARMER

Scientific Research to Aid the Farmer . . . New Jobs for Idle Men and Idle Acres . . . Co-ordination of Agencies into One Chemurgic Enterprise

By FRANCIS P. GARVAN
President, The Chemical Foundation, Inc., and the Farm Chemurgic Council

DURING the last few years, we have all been more or less painfully aware that many millions of our people have been deprived of things that they should reasonably have, and certainly not the least of these things is *work*.

It is often said now that times are getting better. Nevertheless, there are still many millions of idle hands. Even though every mouth is fed, and everybody clothed and housed, we shall still be a very sick nation if so many of our people are deprived of *work* which they are eager to do. It is obvious, therefore, that the re-employment of idle men and of idle acres is still the basic problem confronting America today. Solve this problem and the economic ills of the nation will subside.

Unemployment has been the arch villain of all depressions in the past and will so continue in the future. It is well, therefore, that we determine what past experience might contribute toward the solution of this problem of unemployed men and acres.

History discloses that relatively recent depressions finally terminated and were followed by the return of men and acres to prosperous employment because of two things, namely: 1, Expanding markets for old industries; 2, Creation of new industries. It further discloses that unemployed acres and men, including subsequent growth in population, have been absorbed in our national economy in approximately the following ratio: About one third due to expanding markets for old industries, and about two thirds due to the creation of new industries and the development of new products and new methods.

IT is confidently predicted that with the return of confidence in business; stability of exchange; balanced budgets; and through reliance on sound economics, the expansion of markets for old industries will occur in the natural order of things. This should absorb about one third of our unemployed. But what we are concerned with today is the two thirds dependent upon new industries for their return to productive enterprise.

Statistics in support of our dependence upon new industrial enterprises are not available in precise form as they relate to any particular depression. However, by taking a term of years, which is the safer method, there are ample figures in support of this contention. For example, let us take

The Author

the record of the four decades from 1890 to 1930. We had several depressions during those years including one major depression; namely, in 1893. We escaped another major depression in 1914 only because of the outbreak of the World War.

In those four decades our population was increased by 60,000,000 persons, of whom 40,000,000 gained their subsistence from new industries. What were these new industries? They were the product of modern science and invention developed by American initiative and applied to every-day usage by private enterprise. They fall into two general classifications: the mechanical arts and industrial chemistry.

Specifically, these new industries which have contributed so much to the public welfare include the agricultural implements, air-conditioning, automotive, aircraft, cement, central heating, electrical, food preservation, iceless refrigeration, internal combustion power, modern sanitation, motion pictures, nonferrous alloys, petroleum by-products, radio, steel alloys, synthetic chemistry, telephone, utilities, machinery which lessens the burden of human labor, and many others. Payrolls of these enterprises rightfully are credited with the vast army of men engaged in transportation, distribution, servicing, and maintenance of their respective products. Some of these industries will continue to enjoy a slow but steady growth. Others are still in their infancy and have a brilliant future.

IN 1890, the genius of Edison and his contemporaries had hardly begun to touch American life. Kerosene lamps and horse-cars predominated, and telephones were the exclusive luxury of the banker, the judge, the sheriff, the doctor, and the apothecary. Today who would surrender the comforts, the well-being, the necessities, and the luxuries of life that flow from these very industries—all created through the genius of men like Edison and firmly established through the courage and vision of American industrial leaders?

With few exceptions, these men were of gigantic mental stature. They were business statesmen. Their initiative normally provided employment for 10,000,000 men and women (based on the 1930 census). On the basis of four persons to a family, they furnish material security for 40,000,000 citizens—almost one third of our present population. Without these new enterprises, the United States could not have supported the tremendous increase of 60,000,000 citizens, who were actually added to our population in this short span of 40 years.

All of these industries owe their expansion to labor-saving machinery which has reduced selling costs, broadened markets, and pyramided consumption to a gross volume impossible with hand-labor methods, thereby increasing—not decreasing—the demand for labor. Scientific research and inventive genius furnished the brains. Thus a great variety of articles now within reach of the great mass of our people would have remained luxuries of the wealthy but for the savings in cost that accompany modern mechanical production.

Critics of the machine, afflicted with the spirit of defeatism, might well take

notice of one concrete illustration of how the American system of quantity production through labor-saving machinery in reality creates more jobs than it ever destroys.

The first commercial radio broadcasting station in the world (WWJ) was established by the Detroit News on August 20, 1920. At that time the station had one man on its payroll. A few citizens had cheap crystal receiving sets. A short time ago, this station celebrated its sixteenth birthday, at which time Dr. Lee DeForest announced that there are over 600 commercial broadcasting stations in the United States giving continuous full time employment to over 50,000 technicians, operators, and miscellaneous employees. This does not include the artistic talent engaged in actual broadcasts. Likewise, instead of a few crystal sets, there are now over 25,000,000 vacuum tube receiving sets in use throughout the country.

THE tremendous opportunity for employment afforded by the expansion of this one new industry within a short span of 16 years is sufficient evidence to prove that never in the history of the world has any industrial system been developed that contributes more to the general welfare than the American system. Free competitive enterprise made it possible.

We are now on the threshold of a chemical revolution which, within the next generation, will accomplish as much for the well-being of society and for the broadening of opportunity for employment as did the mechanical and electrical revolution in the two score years referred to previously. As stated before, the creation of new industries is dependent upon scientific research and American inventive genius plus the courage of industry.

This is the task—the creation of new industries—which has been recently undertaken by the Farm Chemurgic Council, the new recruit which has joined in the battle against enforced idleness of men and of acres.

One should explain the meaning of this new word, "Chemurgic," for a great deal will be heard about it in the future. It comes partly from the ancient Egyptian word "chemi," the origin of our modern word "chemistry"; and partly from the Greek word "ergon," meaning "work." Thus, "Chemurgic" literally means "putting chemistry to work." And of course "Farm Chemurgic" therefore means putting chemistry to work in industry for the farmer.

If any one of us has been enjoying the privilege of doing something and loses his job, his natural tendency is to try to find something else to do. What the Farm Chemurgic Council is doing is to react the same way as a powerful social group. In other words, it seeks to find, on a national scale, *something else to do* for those millions of our citizens who are now cursed with enforced idleness, and something else to do for those millions of acres producing more of certain commodities than the market can profitably absorb under present conditions.

Courtesy *Dallas Morning News*

One may reasonably ask why emphasis is placed on the farm problem in this movement. The answer is brief and to the point. The economic illness of the nation cannot be cured until the buying power of the large rural fraction of our population has been greatly increased. This rural group *must* buy, if the industrial group is to be continuously employed in manufacturing.

But agriculture, in turn, cannot buy unless it can farm enough of its acres profitably. And since now the task of producing food alone does not require a sufficient acreage of our land, it is plain that we must turn to non-food uses for products of the farm, and develop industrial processes and new outlets for these products. Thus we see that industry and agriculture are concerned, *together*, in seeking a common economic cure.

Then, you may ask, why does science come into the picture? The answer to that question is also clear. On a national or social scale, the attempt to find new things to do simply means research—scientific research. And by that term, scientific research, we do not mean chemical investigations alone. All the sciences must do their best to help discover *new regions of human activity*. Chemistry happens to be a major unit in the scientific army seeking the advancement of human welfare; hence its name has been chosen as a part of the name of the Farm Chemurgic Council.

Modern men of science, particularly in the field of chemistry, are teaching progressive men of industry how to separate the ingredients contained in the organic products of the soil and re-combine them in different forms for industrial use. Here we have the basis for a host of new industries, all pointing the way toward the return of enduring prosperity. The movement to accelerate these new industries began a year ago last May (1935) when Mr. Henry Ford was host to several hundred public-spirited citizens at Dearborn, Michigan, representing agriculture, industry, and science. Their avowed purpose was and is "to advance the industrial use of American farm products through applied science."

OUT of this original conference has been organized what is now known as the Farm Chemurgic Council. It is not a governmental agency, nor is it political. It certainly has something better to do, and more important to all of us, than to concern itself with the advancement of anyone's personal political fortunes. It is simply a group of far-sighted and public-spirited men who realize the magnitude of the economic problems confronting this nation, and who are unselfishly giving time and effort toward their solution.

The members of this council are men who carry large responsibilities in their respective enterprises. They recognize that prosperity cannot be sectional, that no one can be truly prosperous unless everyone is prosperous. In admirable contrast to the demagogue who would *lower* the standard of living of all by dividing the wealth of the few, these men have set themselves to the task of *raising* the standard of living of all by creating new sources of wealth within the nation.

The purpose of the Farm Chemurgic Council is: To survey the variety of farm products which, through applied science, can be transformed into raw materials usable to industry; to define the scientific research problems essential thereto; to stimulate appropriate research both in public and in private institutions; to activate American indus-

IF we accept the principle that good is bound to come from adoption of the "scientific attitude"—and who does not!—then we can know that splendid results are inevitable from the work of the Farm Chemurgic Council. Here at last is something over which we, long past our days of wide-eyed wonder at the marvels of progress, can sincerely enthuse. Here at last is genuine help for the farmer, and we predict that it will bring to a clear focus a problem that hitherto has been attacked in hit or miss fashion. Even so, the projects sponsored by the Farm Chemurgic Council must often be experimental. Trial and error or—as the scientist calls it—fact-finding, will be the rule. For example, one of the first major projects it is sponsoring—power alcohol from farm products—is at present a highly controversial subject, one which many level-headed experts claim is economically unsound. The Council expects to get the facts. It will get the facts on this and other important subjects and in the end the farmer and the nation will benefit—*The Editor.*

try to apply the fruits of research; to encourage the joint co-operation of agriculture, industry, and science in promoting this significant development nationally.

The commendable hope is entertained that such co-operation will: 1, Result in the gradual absorption of much of the domestic farm surplus by domestic industry; 2, Put idle acres to work profitably; 3, Increase the purchasing power of the American farmer on a stable and more permanent basis, and, thereby—4, Increase the demand for manufactured products, and, thus—5, Create new work for idle hands to do; revive American industry; restore American labor to productive enterprise; and help relieve the economic distress of the nation.

Every dollar used in support of the Farm Chemurgic Council has been supplied by the Chemical Foundation, Inc. and by no other source, directly or indirectly. In its work, the Council invites the co-operation of all related agencies engaged in agricultural, industrial, and scientific pursuits. The co-ordination of the talent thus made available is the Council's task.

THE members of the Council are positive in their convictions that, through orderly and persistent development, American industry will be able to absorb a major portion of the normal surplus of the American farm and thus gradually obviate the necessity of processing taxes, benefit payments, farm subsidies, and other temporary remedies.

That this is not a fairyland prophecy is indicated by the agencies already co-operating. A few of them may be named as follows:

Certain scientific agencies of the Federal Government; majority of the Land Grant colleges; many of the leading universities; Ford Motor Company; E. I. du Pont de Nemours & Company; The Chemical Foundation; Mellon Institute for Industrial Research; The National Grange; American Farm Bureau Federation; leading paint and varnish manufacturers; large processors of food products; manufacturers of farm machinery; the large chemical industries; and many other institutions.

One basic idea favored by the Farm Chemurgic Council is that of promoting the production, in this country, of crops and crop products which are now being supplied to us by foreign countries. Equally important are the Council's effective efforts to encourage and to induce financial support for greatly increased activity in the scientific research laboratories of the country. The result of such research will be *new* uses for many of our farm products, and along with this, the creation of much greater demand for them.

Dominant among the developments of this kind, already begun, is the project of power alcohol. There is some conflict of opinion, but not of enlightened interest, between the advocates of power alcohol and the petroleum industry; nevertheless, authentic tests have shown that the use of alcohol in a motor fuel blend is efficient from an engineering standpoint. Certainly its use nationally would be of tremendous benefit through bringing many millions of idle acres back into profitable production. You are going to hear a great deal more about this power alcohol question as the development makes further progress.

The Chemical Foundation is aiding in the construction and demonstration of the first power alcohol plant in the United States at Atchison, Kansas. The Farm Chemurgic Council is aiding in the technical phases of the work. The plant has a capacity of 10,000 gallons a day.

Orders fourfold in excess of plant capacity have been received. The alcohol will be used for blending with gasoline for motor fuel in middle western states. The plant is so constructed that a wide variety of farm products such as grains, sugar beets, cull potatoes, and Jerusalem artichokes may be used in alcohol distillation in order to arrive at dependable cost and yield data.

A SURVEY of new Chemurgic enterprises launched within the last year since the First Dearborn Conference justifies the estimate that no less than 50,000,000 dollars are being invested in new industries which will use factory crops raised on American farms for raw materials. These new industries include American paper mills, power alcohol for motor fuel, vegetable fiber plants, expansion of the plastic industry, new uses for cotton, tung oil development, soybean plastic and oil extraction plants, starch from southern sweet potatoes, furfural from oat hulls, and other miscellaneous new products.

This splendid progress is the constructive answer of American inventive genius and enterprise to the unemployment and farm surplus problems.

It is particularly gratifying to report that the fruits of the research conducted by Dr. Charles H. Herty in the utilization of southern pine in the manufacture of both kraft and newsprint paper are now receiving attention. (See "Southern

An experiment discussed fully in this journal in 1931 in which the entire cotton plant is harvested and baled. Increases in yield of alpha cellulose are indicated

Pine for White Paper"—Scientific American, May, 1934.) Dr. Herty's work has been financed principally by the Chemical Foundation and is a part of the Council's program.

The seven new paper plants now under construction in the South represent an investment of over 40,000,000 dollars and will have a combined capacity of about 1500 tons a day. It is estimated these seven new mills will give full time employment to 5000 persons working in the mills, and in addition will furnish profitable work throughout the year for 15,000 others working in the timberlands.

Those familiar with the possibilities of this new development—the perpetual supply of rapidly growing pine available, and the economy in operation—forecast that this is but the beginning of a new half billion dollar paper industry that will be established in the South within the present generation. Millions of acres of worn out cotton lands will be reseeded in pine; permanent progress will be made toward solving the surplus cotton problem; and profitable employment will be furnished several hundred thousand men.

Next to the South where 39 percent of our forest lands are located, come the western and northwestern states, the forested areas of which comprise 26 percent of our timber resources. There the hitherto much despised hemlock has been re-discovered as a valuable source of pulp for paper making and of alpha cellulose for the manufacture of rayon.

NOTABLE among recent western developments is the new 200-ton a day pulp mill being erected at Everett, Washington, by the Weyerhauser lumber interests, which will provide profitable use for hemlock formerly neglected in the forest. Modern chemical discoveries have made this development possible.

Marked progress has been made in the use of cotton membrane mesh for reinforcing bituminous roads in secondary highway construction. The Department of Agriculture has recently allotted 1,300,000 dollars to purchase and furnish free, sufficient cotton membrane to build experimental sections under varied climatic and soil conditions in every state of the Union.

When you realize that competent highway engineers estimate that of the 900,000 miles of now unimproved dirt roads in the country where traffic requirements justify surfacing, 600,000 miles will ultimately be given a bituminous paving, you can begin to visualize the potentialities spread out before us. On the basis of from eight to ten bales of cotton per mile of cotton road built, those 600,000 miles of new unimproved roads represent a potential market for from 5,000,000 to 6,000,000 bales of cotton. This is aside from additional requirements for annual maintenance.

The plastic industry is making splendid progress in new developments involving the use of both inorganic minerals and organic products from the farm in the manufacture of a wide variety of useful products.

New tung tree plantings have been made in southern states, notably in Texas, Mississippi, Alabama, Georgia, and Florida. It is believed that the output of 1,000,000 acres of southern tung trees

Irénée du Pont, Henry Ford discuss industrial uses for farm products

can be consumed in this country as rapidly as they reach commercial maturity, which is about six years after planting.

Substantial progress has been made in the utilization of soy-bean proteins and soy-bean oil in industry. Soy-bean production in 1935 (39,000,000 bushels) was almost double that of 1934, yet the demand was so great that importations were made from Manchuria equivalent to the output of 1,000,000 acres. Many automobile parts are now made from soy-bean plastics. The use of soy-bean oil in place of other imported vegetable oils in the manufacture of certain paints and lacquers is now an accepted standard practice in the paint and varnish industry.

I. C. Bradley, President of the National Soybean Processers Association, points out that the saturation point in the use of the soy bean and its by-products is far in the distance: "So many new uses are being found that it is easy to believe claims of chemists and of economists that the soy bean will take its place as one of our major crops."

Everything that grows in the vegetable kingdom is being analyzed by scientists, investigated by industrialists, and contemplated by agriculturists with the end in view of creating new industries, new products, and new methods, all of which means new jobs for the unemployed. It is a better future than has ever yet beckoned our people onward. The co-operative effort of these men is the answer to those "alarmists" who prophesy falsely that eventually the American farmer must retrograde to the status of the European peasant.

THE opportunities are legion: non-poisonous insecticides made from the painted daisy or pyrethrum; cork from domestic oak trees; wines and beverages from surplus fruits; perilla oil for paints; building material from bagasse or waste sugar cane; alpha-cellulose from the whole cotton plant (See "Cotton Stalks, a New Source of Rayon," Scientific American, October, 1931); increased domestic production of sugar; tanning materials from the Sourdock weed; domestic fiber from hemp and flax; domestic raw materials for rubber; rayon and Cellophane from a wide variety of plant life; and so on.

Summarizing, the Farm Chemurgists envision displacing eventually some 250 million tons of raw materials now drawn annually from the mineral kingdom by a like amount of organic (farm) products from the vegetable kingdom, all for industrial use in the United States.

A century ago the mineral output in this country was one half the farm output, measured in tons, and we had no serious unemployment problems. Today, the mineral output is about one billion tons, the farm output is one half billion tons, and unemployment threatens our social order. The switch suggested would make the output of each kingdom about 750 million tons. It would give us a farm population of close to 40 percent of the total population and would provide gainful employment for every man and woman qualified and willing to work.

This change would mean increasing agricultural production, instead of decreasing it. It would give us a better balanced distribution of population and would bring about a gradual decentralization of industry. Congestion of population in large cities, which is the real threat to modern civilization, would be retarded. Man, once again, if he so chooses, would be able to live a wholesome existence.

In the words of Mr. Louis J. Taber of the National Grange, the co-operation of agriculture, industry, and science to this end is "Our Greatest Economic Trinity."

And to quote Mr. Henry Ford's words at the First Dearborn Conference: "I believe that industry and agriculture are natural partners. Agriculture suffers from lack of a market for its products. Industry suffers from a lack of employment for its surplus men. Bringing them together heals the ailments of both. I see the time coming when the farmer not only will raise raw materials for industry, but will do the initial processing on his farm. He will stand on both his feet—one foot on the soil for his livelihood, the other in industry for the cash he needs. Thus he will have a double security. That is what I am working for."

REFLECTION NEBULAE

Large Opaque Clouds of Dark Particles in the Galaxy are Lit Up Whenever Stars are Near . . . New Type of Telescope Confirms an Older Theory

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society.

ANYONE who looks carefully at the Milky Way must be impressed by its irregular and patchy appearance. Even the fainter stretches of the Galaxy in Auriga, Gemini, and Orion, which are seen in the winter skies, are far from uniform, and the brighter part which we observe in summer is full of brilliant areas and darker regions. Our eyes are handicapped in detecting this, for much of the most remarkable structure is too faint to be easily detected by direct observation—especially if the air is even slightly hazy or lit up by artificial lights. Long-exposure photographs reveal an extraordinary wealth of detail, some of it remarkably sharp in outline.

A generation ago it was supposed that the darker parts were gaps between the visible star-clouds through which the blackness of outer space was revealed through a foreground of scattered stars. Then Barnard, by a masterly analysis of his own superb photographs, convinced a skeptical world that the dark lanes and patches were caused by enormous opaque clouds—dark nebulae—lying between us and the bulk of the galactic stars, and blotting them out, or at least greatly diminishing their light. Even the great rift which splits the Milky Way in two from Cygnus to the Southern Cross and extends for one third of the circumference of the heavens, comes from a vast cloud, or belt of overlapping clouds, which conceals from us a great part of what would otherwise be the most brilliant region in the sky. When a bright star happens to be close to such a cloud, the neighboring part of the latter is lit up by the starlight and appears faintly luminous. The first evidence that this happened was given in 1912 by Slipher, who showed that the spectra of several of these nebulae were true copies of those of nearby stars, and the proof was completed in the following year by Hertzsprung, who found that the brightness of the wisps of nebulosity in the Pleiades was just what might be expected from a whitish cloud illuminated by the stars of the cluster.

Ten years later Hubble showed that this explanation applied to all the diffuse and irregular nebulae within the Galaxy. When the star whose light excites the nebula is exceptionally hot, the light of the latter comes mainly from atoms of gas, but if the star's temperature is less than 20,000 degrees, the nebula shows a continuous spectrum such as would be expected from reflected starlight (if observed with a spectroscope not powerful enough to show the dark lines). The brightness of the starlit nebula naturally fades away at a distance from the star, and Hubble's measures show that the distance at which it ceases to be perceptible, on photographs taken with the same telescope under similar conditions, increases with the apparent brightness of the star in just the way which might be expected on simple geometrical principles.

The evidence that these nebulae shine by reflected light was thus made conclusive, but one further test might be imagined. Nebulae lit up by stars of different colors, and reflecting their light, should themselves be colored correspondingly. Are they so in actual fact?

IT is much easier to ask this question than to answer it, for it is one thing to show that a faint object exists and a very different one to find out what color it is. Direct visual observation, which is the first thing one would think of, is hopeless; the human eye, exposed to fainter and fainter light, loses its sense of color long before it ceases to appreciate the existence of a luminous form. One may see this for himself without laboratory apparatus. It suffices to take an electric stove into a dark room and switch it off after the wires and their supports are red hot. The fading light, at first a good cherry red, loses color as it weakens and the last faint glimmer looks almost gray—though, as a matter of fact, the radiation emitted from the cooling mass contains an ever increasing proportion of the deep red and infra-red rays.

Color in objects as faint as these nebulae can be detected only by photography, comparing images on an ordinary plate sensitive mainly to the violet, with those on an isochromatic plate with a yellow or red filter in front of it. The latter gives pictures on which the relative brightness of red and white stars is very much as it appears to the naked eye: on the former the red stars are much fainter—the plate is insensitive.

One of the best examples in the sky is the constellation Scorpio. Antares, its brightest star, is very red, of spectral class M, but has on each side a pair of blue-white stars (Class B) which, to the eye, look only one fifth as bright. On an ordinary photograph Antares is the faintest of the three, so that the whole appearance of the constellation is changed. In this familiar group nature has supplied us with the desired test under conditions as definite as could be provided by a pre-arranged experiment. Antares and its neighbors—including a number of bright stars to the north and west—belong to a moving cluster and are undoubtedly physically connected. The neighboring region of the heavens is noteworthy for some of the blackest and most opaque dark nebulae which are known, and these in the vicinity of several stars of the cluster are lit up in the characteristic way which has just been described. Ordinary photographs show this illumination strongly around a number of the white stars but only a faint glow near Antares.

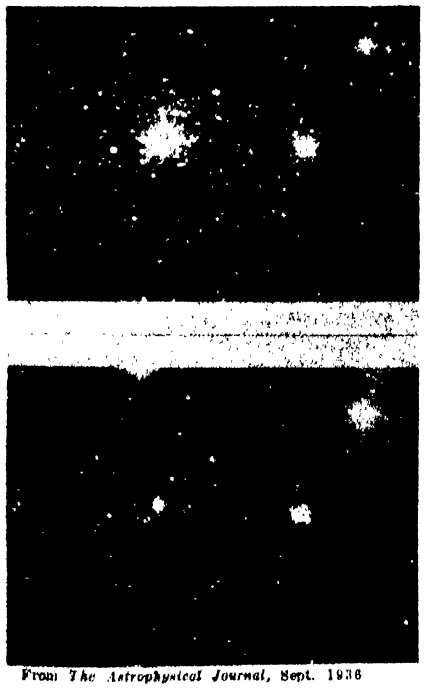
The critical test with yellow light has been made by Struve, Elvey, and Roach, of the Yerkes Observatory. These photographs were taken at the new McDonald Observatory in the mountains of western Texas—not with the great 82-inch telescope, which is not yet completed, but with a small but very efficient Schmidt camera—of the type described a few months ago in these pages. This has a mirror with four-inch aperture and seven-inch focal length and gives small but very sharp images. For revealing faint, extended luminous surfaces it far surpasses the great reflector itself.

Photographs taken with this camera, using yellow and red light only, show Antares as the brightest star in the constellation and reveal a large diamond-shaped nebula more than a degree in length, which is barely visible on the plates taken with violet light with the same camera, while the nebulae sur-

rounding the blue-white stars behave in just the opposite way. The plates were carefully standardized so that they show not only that the colors of the nebulae differ but just what they are. After correction for the general foreground light of the sky (originating largely in the Earth's atmosphere) which even in the clear Texas sky is greater than that of the nebulae, it is found that the nebula near Antares is strongly red (color index +1.9) and that near the other stars blue (-0.4) and that in both instances the color of the nebula matches closely that of the star which lights it up. No more convincing proof of the reflection theory could be desired.

Struve and his colleagues state that the new red nebula is "fairly easily visible" visually with a good binocular, provided that Antares is hidden behind some convenient obstruction. It is far too faint, of course, to show any trace of color, and attempts to see it, except in very clear mountain skies, are likely to be futile.

THESE investigations confirm the conclusion that these great interstellar clouds—dark and light alike—lie at substantially the same distance as the stars of Scorpio or a little behind them. From the motions of these stars Kapteyn showed that their distances from the sun range from 350 to about 450 light-years. The distance and size of the nebular clouds follows at once, and the results are astounding. Some of the heavy dark clouds are as much as 50 light-years long, from five to ten light-years wide, and probably equally thick. To compute their bulk is easy enough to anyone used to reckoning in powers of ten, but the results are hardly comprehensible.



From *The Astrophysical Journal*, Sept. 1936

Above: **Nebula near Antares (center) revealed with Schmidt telescope camera and yellow filter.** ***Below:*** **Same, ordinary photograph**

A cloud 50 light-years long and 5 light-years square contains 1250 cubic light-years, or 10^{12} cubic kilometers. The "few octillions of cubic leagues of space"—of which Walt Whitman spoke in one of his grander flights—amount to only 10^{9} cubic kilometers. The nebula is bulkier in the ratio of the whole national debt of the United States to the postage on a single letter!

Vast as it is, the nebula must be of excessively low density. A simple calculation shows that if its density were as great as a thousand-billionth part (15^{-12}) that of ordinary air, it would contain matter enough to make 650,000,000 stars similar to the sun. A mass a thousandth part as great would attract the stars even 50 light-years away so strongly that a large proportion of them would move around it in closed orbits. The observed motions show not a trace of this, and we may conclude that the average density of the nebula is less than 10^{-15} grams per cubic centimeter; that is, less than one ounce in 7000 cubic miles.

The wonder now is how anything so excessively tenuous can be opaque. But another simple calculation shows that if we took our 7000 cubic miles and stretched it out into a column long enough to extend through the whole five light-years' thickness of the nebula, it would shrink laterally till it was only 2¼ inches square. Now our question looks different. Can we put an ounce of stuff into a tube 2¼ inches square in such a way as to stop light from passing through it? Assume that our "stuff" is as dense as rock. A single piece weighing an ounce would be about an inch in diameter and could not cut off the light; but if we broke it up into sand-grains averaging 1/100 of an inch in diameter, there would be a million of them. Each one would have a cross-section but 1/10,000 that of the lump, but the combined cross-sections of the lot would be several times greater than that of the tube. If they were rammed down along it into one place, they would unquestionably block it, and even if scattered here and there along its vast length, their total obscuring effect would be very heavy, though not quite complete. By grinding our stones to finer and finer powder, the resulting cloud of dust would have more and more obscuring power, so that a completely opaque cloud could be made even with a much smaller density.

There is a limit to this process. So long as the dust grains are larger than the wavelength of the light they will act simply as obstacles and behave as has been described. But when they get considerably smaller than the wavelength, they no longer get much grip (so to speak) upon the light waves; further

Courtesy Dr. Otto Struve

Another photograph, showing the red nebula near Antares photovisually, Antares at the bottom

pulverization makes the cloud less opaque. Even at the unit when the material is broken up into separate molecules—that is, transformed into a gas—it has still some power of scattering and so weakening the light which passes through it, but relatively very little. For a homely illustration of this, one may recall that a few inches' thickness of "steam" emitted from a pipe (that is, of one containing a very small percentage by weight of small drops of condensed water) will obscure the sun, whose rays pass with but little weakening through all the miles of atmosphere above our heads.

It is probable, of course, that the dark nebulae contain particles of all sizes, from loose gas molecules to large chunks, if not bodies of planetary size. But of all these, the fine dust, pound for pound, has enormously the greatest light-stopping and light-reflecting power, so that we will *see* the dusty parts of the clouds, whatever else may be there as well.

PARTICLES larger than the wavelength act very much the same upon light of all colors. A cloud composed of them will look white by reflected light (if the incident light is not colored) or, at least, grey, if the particles themselves are dark colored; and light, which has come through it, though weakened, will not change color (like the sun shining through a fog). But particles smaller than the light waves behave quite differently. They react more strongly with the shorter waves, so that a cloud of them will reflect blue light much more than red. The molecules of clear air behave thus: hence the sky is blue, while the light of the setting sun, which has escaped the scattering, has lost most of its blue and looks red.

The clouds in Scorpio and Ophiuchus, which scatter light of nearly the color of the stars which illuminate them, must be composed mainly of particles of the larger sort. Another nebula near the yellowish star Gamma Cygni, and eventually illuminated by it, shows, however, a decided bluish color and must be formed mainly of small particles.—*Princeton, October 3, 1936.*

SPEED WITH EASE

Motor-Car Speed a By-Product of Efficiency . . . Can Kill or Save . . . What the Manufacturers Are Doing About Safety . . . The Penalty of Speed

By JOHN HENSHAW CRIDER

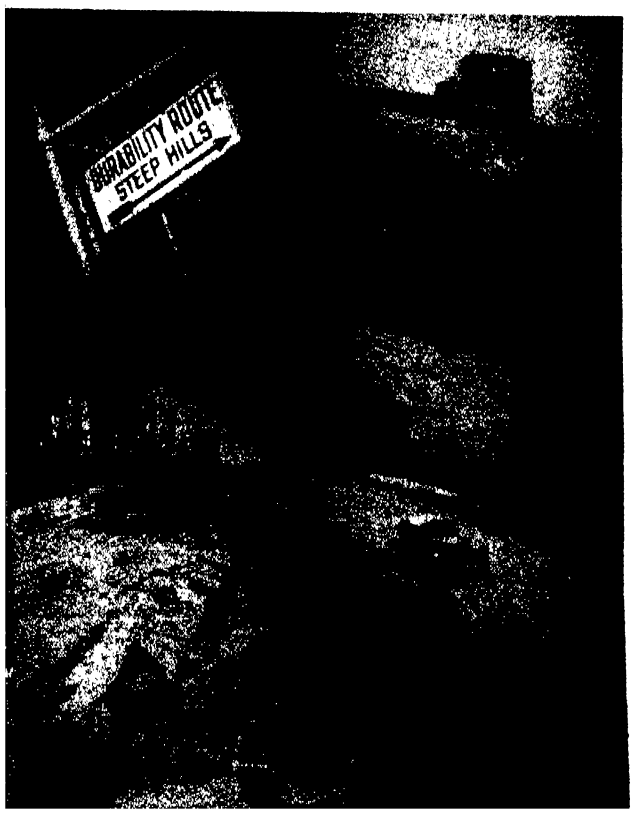
YOU'RE passing a car on the long straight-away of a two-lane highway, and you've misjudged the speed of an approaching vehicle. It's coming faster than you thought. You're already doing 50. You step down on the accelerator and pray that there is enough reserve power to get you through that rapidly closing hole. The car leaps forward, spurting gracefully to safety. It's got power, all right; it's got speed to spare; only that reserve power prevented tragedy. The engine compensated for a miscalculation of speed and distance. None of us always judges such puzzling elements of safe driving without an error. And when mistakes occur, as they occasionally will, it's a comfortable feeling to have that extra power and speed under foot.

As you look back on that experience, you realize your old gasoline buggy would never have been equal to that sudden extra burst of speed without a remarkably powerful motor. It would not have had that capacity for spurting ahead if the engineer hadn't put that smooth, 80 horsepower engine under the hood. You're mighty glad he did.

In spite of this and similar experiences with which every driver is familiar, the biggest argument in the realm of automobile safety today is over the question of speed. The majority of car buyers seem to want it, the manufacturers declare it is essential, and yet enforcement and safety officials insist that it's dangerous. As the 1937 models roll off assembly lines into showrooms around the country, it is interesting to consider some aspects of this matter of speed and what is being done about it. It has a great deal to do with the future of automobile manufacturing, and, needless to say, it has a strong bearing on the popular question of highway safety.

No one in his right mind says that speed is the only cause of automobile accidents, but, as you will see, there are some who believe it is a leading cause of fatal crashes. Accidents are caused by (1) the car, (2) the driver, (3) the highway, or (4) the other fellow who, incidentally, is just another driver like you and me. Most accidents occur while cars operate at slow or moderate speeds, but the greatest percentage of *fatal* accidents happen when cars are going too fast.* Over 30 percent of all fatal accidents in 1935 occurred when cars were driven too fast. Now what are people saying about this question of speed? Who are the objectors, and who the defenders?

Safety factors at all speeds of which new cars are capable are checked by grueling tests on proving grounds



A spokesman for the automobile industry pointed out that in several European countries, where cars are not capable of speeds as great as ours, the rate of automobile deaths runs two to four times as high as ours. To illustrate a British manufacturer's idea of speed, here is a quotation from an Austin advertisement which appeared in *The Geographical Magazine* (London) of April:

"About time I got a new car—a car that is thoroughly up-to-date. . . . Let's think what I really want it to be like and what I want it to do. Ninety miles an hour? No. It might be a bit of a thrill when one gets the chance but sixty-five is all I'll ever want. . . ."

Compare that with some of the American auto advertisements of a few years ago which gave you the idea that an 80-mile-an-hour car could be driven through a brick wall without so much as spoiling the driver's hair comb. Speed and strength were the main themes in those days. Note, for example, the following newspaper advertising copy of an American accessory manufacturer which appeared during March of this year:

"WANT MORE SPEED? If you were a racing driver, preparing for a great race, you would test your car with various types of equipment and you would find that you could reach your highest speed only when your engine was equipped with—Spark Plugs."

THERE is little question that the American people like speed and use it. Speed surveys show conclusively that we do travel fast—that is, most of us do. One of the latest surveys, one made by E. L. Springer under Professor Ben H. Petty of Purdue University in which 2023 cars were observed on Indiana highways, showed that 19 percent of the total cars observed traveled between 50 and 55 miles an hour. Sixteen percent traveled at 45 to 50, and another 16 percent at from 40 to 45. Ten percent traveled at 35 to 40, another 10 percent from 55 to 60, and still a third 10 percent from 60 to 65. Six percent drove at 30 to 35, and another 6 percent at from 65 to 70. About 2 percent drove at from 70 to 75, and less than 2 percent at from 25 to 30. About 1 percent drove at 75 to 80, less than 1 percent at 20 to 25, and less than ½ of 1 percent at from 80 to 85. A study of these speeds, published with the observer's report in the March *Better Roads Magazine*, makes it readily apparent that driving under 40 miles an hour is not very popular on Indiana state highways.

Maybe it isn't that people want to drive fast, but simply that the new cars

*See table, page 61, August 1936, Scientific American.

with their smooth acceleration reach high speeds before the drivers realize how fast they're going. For such absent-minded folk, Dr. George H. Stacy of the *Peoria (Ill.) Star* has designed a speedometer which shows the area upwards of 50 miles an hour in red. The zone from 30 to 50 is colored in yellow for caution, and below 30 the background is green.

A similar speedometer design, which tells the driver not only the speed he is traveling, but how many feet per second, the average braking distance for each

Courtesy Ocean Accident and Guarantee Corp., Ltd.

A perfect setting for an accident that speed and power may prevent

speed, the reaction distance, and the average stopping distance, was prepared by Emanuel Gorfine, speaker of the Maryland House of Delegates, and appeared on the cover of the July issue of *Keystone Motorist*. Many persons who drive habitually at speeds over 40 miles an hour would probably slow down if they had at hand the figures supplied by Speaker Gorfine's speedometer.

"There is a very definite line of demarcation between the speed at which a car can be controlled, and the next higher bracket of speed at which the driver is practically helpless when a crisis arises," said John W. Wheeler, member of the Indiana State Highway Commission, writing in *Civil Engineering*. "The speed of an automobile can only be regulated in its design on the drafting board. Until a maximum speed is set, and the automobile is designed and the highway built for that speed, American accidents will increase in spite of all that highway engineers can do to prevent it."

Mr. Wheeler was thinking principally about the highway as a cause of accidents. Narrow roads, bad pavements, needlessly sharp curves, narrow or worn out bridges, and lack of proper marking are certainly among the important contributors to highway disaster, but these things would not be so important if automotive science had not given us high speeds. Mr. Wheeler feels that the top speed of cars should be decided upon and fixed once and for all. Then, he says, engineers could build highways to accommodate the established speed with safety for the motorist.

Barney Oldfield, veteran automobile racer, told an Associated Press reporter in Los Angeles that speed should be left to the race tracks.

"I've driven over a million miles in automobiles," he said, "and I've only struck one pedestrian. At the time of the accident I was eating popcorn and my mind was not on my driving."

The silly part of motor-car speed is that when we drive too fast we don't get the maximum economy out of our motors. B. H. Anibal, chief engineer of the Pontiac Motor Company, reported that tests on the General Motors Proving Grounds showed that while the best mileage delivered by one of the test cars was 24 to the gallon of gas, the same car could do only 13.9 miles to the gallon at 70 miles an hour. At 50 you get from 25 to 30 percent more mileage than at 70.

A SEVERE critic of high-speed automobiles is Dean A. Fales, associate professor of Automotive Engineering at Massachusetts Institute of Technology, who says: "Many of the new cars are so much faster and smoother than the older cars that the driver is deceived as to his speed, and when he meets an emergency, both he and the vehicle are unable to cope with it. Excessive speed is one of the real dangers on the highway today."

The New York Times took a leading place, editorially, in denouncing fast driving. After reviewing an analysis of last year's accident figures, the following statements were made: "These figures should dispose once and for all of the argument that it is 'old fashioned' to emphasize speed as the most important factor in the alarming rise in the automobile death rate. . . . In collisions, no matter what the cause, it is generally speed that kills. . . . Even among those who refuse to concede that higher speeds increase the number of accidents, no one

Photographs courtesy General Motors Corp.

The automobile industry uses many delicate scientific instruments to measure safety factors in the laboratory

can deny that they increase the destructiveness of the accidents that do occur. . . . It is little wonder that two thirds of all fatalities to occupants of automobiles occur at speeds in excess of 45 miles per hour."

Professor Amos E. Neyhart of Pennsylvania State College, pioneer exponent of public school instruction in safe driving, declared that an analysis of 2571 highway deaths in Pennsylvania during 1934 showed that 56 percent were due to "exceeding speed limit or driving too fast for conditions."

It was perfectly natural, in view of the public clamor, that Secretary Daniel C. Roper, in announcing some of the objectives of President Roosevelt's national safety survey, should have asked: "Why is it necessary to manufacture cars with speeds from 80 to 100 miles an hour?" And again: "What steps are being taken by dealers to insure the public against the selling of high-speed cars to reckless, disabled, or incompetent drivers?"

The automobile industry couldn't afford to sit back without saying or doing something. After all, the manufacturers have a right to a hearing on matters so vital to their well being. One of the strongest blasts against them was a front-page editorial in the *Detroit News* which brought an immediate answer from the industry. The editorial said in part:

"Let the industry which has given us the cars—so necessary in American life today—establish the rules by which those same useful cars will cease to be weapons of death and injury.

"THE AUTOMOBILE INDUSTRY MUST NOT LET THE AUTOMO-

BILE COME TO BE KNOWN AS A KILLER!"

Alvan Macauley, president of the Automobile Manufacturers' Association, answered the challenge in part as follows:

"A long continued investigation of traffic accidents shows that they are due to a great diversity of causes, chief of which is the fact that our cities were laid out for horse drawn traffic at a time when the automobile was not dreamed of, and when the present congestion of street traffic was beyond the imagination of anyone. But there are many other existing causes, some of them more readily curable than by the rearrangement and widening of the streets of a great city."

MR. MACAULEY called attention to the industry's establishment of the Bureau for Street Traffic Research at Harvard University, which is generally regarded as the most competent organization in the country for solving street traffic problems. The bureau has provided fellowships to deserving students. Dr. Miller McClintock, director of the bureau, has said that "speed as a function of the motor car, just as sharpness as a function of a knife, must be recognized on its face value, and instead of destroying it, we must surround it with those controls which assure reasonable protection."

Said Ray W. Sherman in his book, "If You're Going to Drive Fast": "It is not logical to expect our evolution to be toward slowness when the major inherent quality of the automobile is speed, and its road is made smoother. No matter what is or what isn't logical, I don't believe we are going to do much slowing down. But we must have more safety!"

William S. Knudsen, executive vice president of General Motors, had the following to say about the speed controversy: "We spend a great deal of money every year finding out what our customers want. So it is with considerable confidence that we tell you that they want cars which will accelerate quickly, negotiate the majority of hills without gear shifting, and transport them at a fairly rapid rate of speed. We are confident that the public will not buy cars which do not have these performance characteristics, no matter what we as individuals may think about it."

You probably recall that in the August issue of Scientific American Professor Alexander Klemin of New York University gave other important reasons why speed and power are built into the modern motor car: "(1) Everyone likes to get going just as quickly as possible; (2) if the bare minimum of power just sufficient for good speed on a level road were provided, hills would become an intolerable nuisance; (3) engines or other machinery operating at the highest pressure will never work with the same perfection and reliability as when working well within maximum capacity."

Robert S. Mann predicted last fall in *Editor and Publisher* that any advertising copy "which places undue stress on speed—even though it may sell cars—will be found to build public resentment not only toward the individual manufacturer, but toward the whole industry."

Measuring carbon monoxide seepage in a new car. Drivers, drowsy from CO, may cause accidents

The industry took heed. The handwriting on the wall was conspicuously clear. All you have to do is look at the new 1937 models, read their safety specifications, and you'll be convinced that the manufacturers are co-operating 100 percent with safety demands. They still have speed and reserve power for the reasons stated by the industry's spokesmen. Without these qualities, as you can appreciate, the automobile would be a sorry piece of merchandise. Nobody would want it. This very need for reserve power and emergency speed is the reason that governors are not popular either with the public or the manufacturers. They seriously cripple a car in its performance characteristics and thereby reduce safety margins.

The 1937 manufacturing and advertising credo of the Automobile Manufacturers' Association, which is the industry's answer to the alarming cries of the past twelve months, pledges that every safety factor proved by research and engineering will continue to be built in American automobiles. The most radical decision of the manufacturers was to eliminate from their advertising and publicity "all references to vehicle top speeds."

This pronouncement is of historic importance because it marks the end of the industry's efforts to sell speed to the public. Having spent millions of dollars to sustain and satisfy a demand for speedy motor transportation, the manufacturers now agree to drop the emphasis on speed and sell safety. After all, it is security that the public wants most of all, and the industry is answering that demand.

BUT safety is something which the industry alone cannot supply. In the final analysis it is up to the driver. Given a fast car which is safe under reasonable conditions, it is the responsibility of the driver to adhere to those conditions. Unless the driving public proves itself worthy of being intrusted with fast motor cars—and that means you and me—government may intercede and take the privilege away. The National Bureau of Casualty and Surety Underwriters, in the booklet, "Man and the Motor Car," presents this warning: "In a frantic attempt to reduce death and injury on the highway, any one of dozens of drastic measures may be put in effect that will kill the pleasure and curb the natural liberty of citizens who want to move in motor cars. Under such conditions, the use of automobiles will manifestly decline."

If you think this is idle talk, hearken to the 1935 annual report of Charles A. Harnett, New York State Commissioner of Motor Vehicles, in which he said: "We urge that a maximum speed limit of 50 miles an hour be established by law in the State of New York, and if enforcement of such a statute and program does not bring about the desired results, it may be necessary to resort to mechanical devices as a means of restriction."

It is plainly evident that the public has little choice in this matter of speed. Either we must use it with discretion, or it will be taken away. The privilege of operating smooth-running, powerful motor cars is one worth keeping. But that has become a matter for drivers to decide for themselves. You will drive at reasonable speeds or be compelled to do so.

●

Simplicity has always characterized motion-picture animated cartoons, and perhaps this very simplicity accounts in large measure for their wide-spread popularity. With the advent of color to these cartoons, they take on an added interest. An article to be published soon tells in detail of the method for producing these colored films.—The Editor.

CHECKING UP ON HURRICANES

Instrument Records Temperature, Pressure, Humidity . . . Microscopic Record . . . Carried Aloft By Sounding Balloon . . . Importance of Data

A TINY instrument, weighing about 1¼ ounces and suspended beneath a small balloon, is science's latest device for finding the whys and wherefores of South Atlantic and Gulf Coast hurricanes. According to W. R. Gregg, chief of the United States Weather Bureau conducting tests of the equipment, the data obtained will add immeasurably to what is already known about hurricanes. The instruments are sent out from three stations—located near Montgomery, Alabama; Jackson, Mississippi; and Augusta, Georgia—operated by the Massachusetts Institute of Technology, co-operating with the government in this study.

Signals for release of the instrument-carrying balloons are given by the Weather Bureau's Eastern District Forecaster at Washington, D.C., who also sets their schedules. From his daily charts of weather conditions all over the world, the forecaster follows every tropical disturbance from the time it appears far out on southern seas, until it has blown a path across the land or has veered to spend its fury over the water.

If the "eye" of the storm—the calm area sometimes ten miles in diameter in the center of winds that blow at velocities up to 200 miles per hour—passes over one of the special observation stations, the instruments will be sent up at fifteen minute intervals. Otherwise they will be released every one and a half to three hours, the interval depending upon the path and speed of the hurricane. This will also decide whether one or all three of the stations will take part in the program.

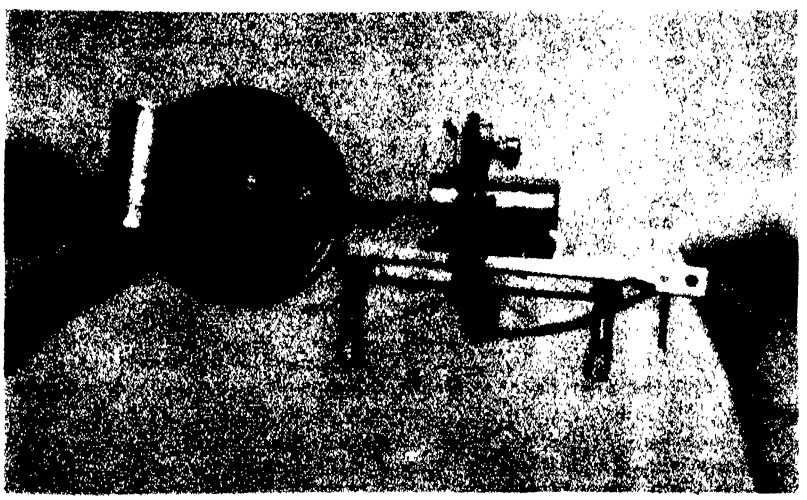
Ready for the upper air: The hurricane data recorder and balloon

The instrument consists essentially of three recording elements, three small penpoints, and a piece of smoked glass about the size of a postage stamp. Fitted into a small aluminum or doped fabric gondola, it is carried by a hydrogen-inflated balloon to a height 10 to 20 miles above the earth at a rate of climb of 650 to 800 feet per minute.

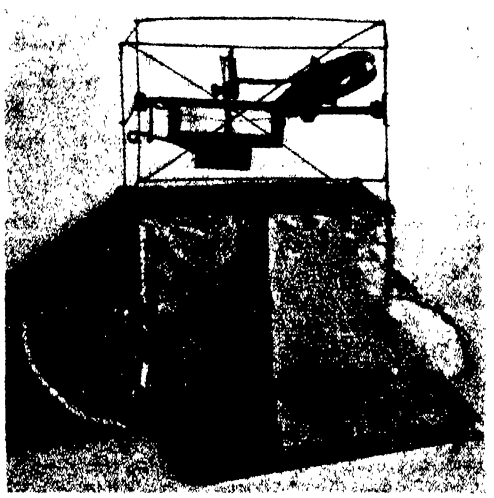
The three elements of the instrument record pressure, temperature, and moisture. The pressure-recording element consists of a small metal capsule from which the air has been exhausted and which contracts or expands with changing pressure. This is attached to the smoked glass plate which rises or falls vertically with the expansion or contraction of the capsule, tracing a record of the pressure changes with a stationary penpoint. The temperature recorder consists of a little cylindrical shell made of two thin layers of metal which coil or uncoil as the temperature rises or falls. This is connected to a penpoint moving crossways over the surface of the glass plate. A third penpoint is attached to a strand of human hair that becomes longer or shorter as the air about it becomes damper or drier.

THE gondola is attached to the intersection of three bamboo sticks which in turn are coupled to the balloon. As soon as the balloon reaches its ceiling and bursts, a mechanism removes the penpoints from contact with the plate so that no records are made during the descent. The instrument is mounted on rubber bands to reduce shock on landing.

Five pieces of red cloth are attached to the bamboo framework to attract attention of passersby to the fallen instrument. A tag offering a reward for return of the device to the United States Weather Bureau station at Boston, Massachusetts, is also attached. There the glass plate will be examined and read under a microscope and tabulations from the recordings will tell an interesting story of what goes on in the heart of a hurricane.



The hurricane recording mechanism. *Left:* Metal coil that records changes in temperature. *Center:* Pressure capsule. *Below:* Hair for humidity changes



The mechanism is shown above with the gondola that protects it during its flight

THE NEW IN HEATING

Heating Industry Progresses . . . New Systems, New Controls . . . Co-ordination with Air Conditioning . . . Radiant Heating . . . The Future

By PHILIP H. SMITH

IMAGINE a house heating system which functions at its maximum only when the house is occupied, and only in the particular room in which the householder chooses to be at the moment. A push of a button would bring on comfort heat while at all other times the temperature would be no more than necessary to prevent injury to the house contents.

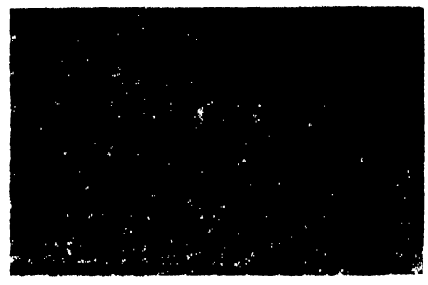
This sounds like a very impractical dream, but it isn't. The lines of approach to such a convenient system have been laid down and it may come to pass in another decade. It will involve a sharp departure in heating practice, but the hurdles to be taken are economic rather than technical.

The heating industry has been making steady progress. Innumerable refinements have been incorporated in existing systems, all aiming to overcome well recognized defects to the end that the user will get greater satisfaction in the form of bodily comfort, and mental comfort as it applies to his pocketbook. More uniform distribution of heat, automatic control of temperatures, reduction of heat losses, elimination of dirt, and improvement in appearance are some of the accomplishments of recent effort.

COINCIDENTALLY with these improvements there has come about a growing appreciation that insulation and air conditioning are inseparably linked with heating. Whether the best in each of these factors in comfort is to be obtained jointly or individually is a moot question not yet decided. The pros and cons have been related already in these pages and need not be covered again to make current gains in heating clear.[1]

The improvements which have the greatest appeal to the home owner are those which are to be classed as control. Controls are now exercised in many ways, but they all contribute to achieve a regulation of room temperatures. It doesn't matter whether the system is steam, hot water, or warm air; nor does it matter what the fuel—better regulation has been given to all. The development of oil burning systems has stimulated similar improvements in the positive control of coal burning, and the choice of systems today depends more upon the local cost of fuels than individual merit.

Distribution of heat throughout a building is now being equalized in a number of ways. If the system is run by steam, vent valves are provided for adjustment so that the radiators nearest the source of heat generation vent air slowly, while those most distant from the boiler vent quickly. When hot water is used, a similar effect is obtained by valves which strangle the flow nearest the heat source. In effect, the heat is metered to the radiators, and thermostats provide automatic control for the entire system.



Radiant heating has many possibilities. *Top:* Pipes in wall before covering with plaster; and *below:* On ceiling

The control of heat losses—in other words, the attainment of greater operating efficiencies—is quite as important from the technical viewpoint as the regulation of heat distribution, although it is not so apparent to the home owner who easily loses sight of costs. In the main, the efficiency of heating systems has been improved in three ways—by better combustion of fuel, improved insulation of heat generators, and more complete utilization of the heat of combustion gases. Economies of this type begin by the exercise of positive control over air and fuel mixtures; are accentuated by jacketing the generators with the water or air used as the medium for transmitting heat; and end by providing an opportunity for combustion to be completed and heat absorbed before escape up the stack. In one type of coal-fired boiler, the hot gases are made to travel four times the length of the boiler before they are permitted to escape; in a new warm-air heating system which employs oil as the fuel, the gases are conducted 36 feet past heat-absorbing walls and fins before they enter the chimney.

Illustrative of the advance made to reduce heat losses and unique among the newer heating systems is a plant which uses gas as its fuel and does away with the need for a chimney. The equipment comprises a combustion chamber, jacketed with water, and an all-copper piping system with radiators. In operation, the hot gases are made to enter a mixing chamber where they pick up water as vapor from the jacket and pass directly to the radiators. Then the cooled gases and condensate pass to the return piping, the condensate going back to the water jacket and the non-combustible gases being discharged through an exhaust pipe. Water made from the hydrogen in the gas overflows to a drain.

The unique feature of running the gases directly to the radiators is made possible by using an exhaust fan which produces about three quarters of an inch of vacuum on the condenser outlet. This provides, in effect, a controlled draft. An additional advantage lies in

[1] *Scientific American*, August, 1936.

the fact that once the intake of gas and air is regulated to insure proper combustion, the ratio remains constant regardless of variations of weather or chimney. Instead of a chimney, a two-inch copper pipe is employed for exhausting the non-condensible gases, and so great is the efficiency that the outlet temperature is as low as 80 degrees, Fahrenheit.

All heating systems on the market today have been vastly improved in appearance and for the most part the enhanced appearance represents a corresponding gain in insulation and reduction in dirt. This applies both to the heat generator and to the distributing system. Concealed radiators have enhanced appearances but not without some loss in heating effect, and the next swing will be in the direction of design which will give considerably more radiant heat.

Quite apart from progress in refinement of existing heating systems a new method has been developed known as radiant heating. It is not widely known in the United States because installations are few and far between, but in Europe where it originated it has become quite common. It is found in many of the British Government buildings, in theaters, stores, auditoriums, and other public and semi-public structures, as well as in many thousands of private homes.

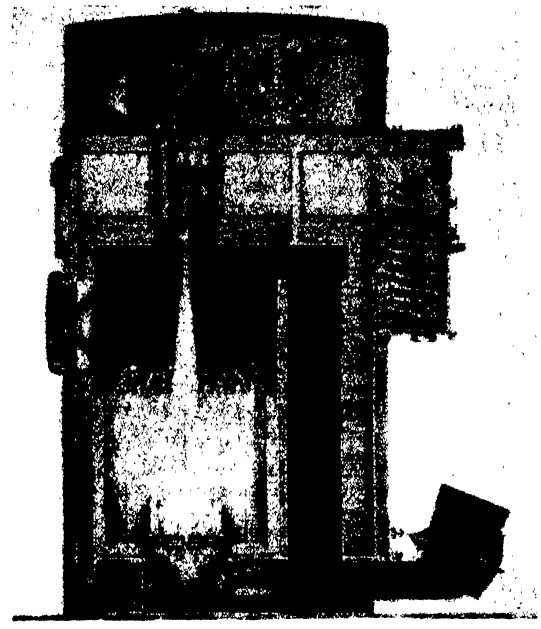
Radiant heating is based upon a very old principle of thermodynamics. As indicated by its name, it employs radiant heat which is a wave or beam of pure energy, rather than the commonly used "convected" heat, the "sensible" heat which is the vibration of the material particles of the body of matter. The old-fashioned fireplace provided more radiant than convected heat. The sun demonstrates this type of heat most impressively as anyone can testify who has experienced comfort in its direct rays during a cool fall day.

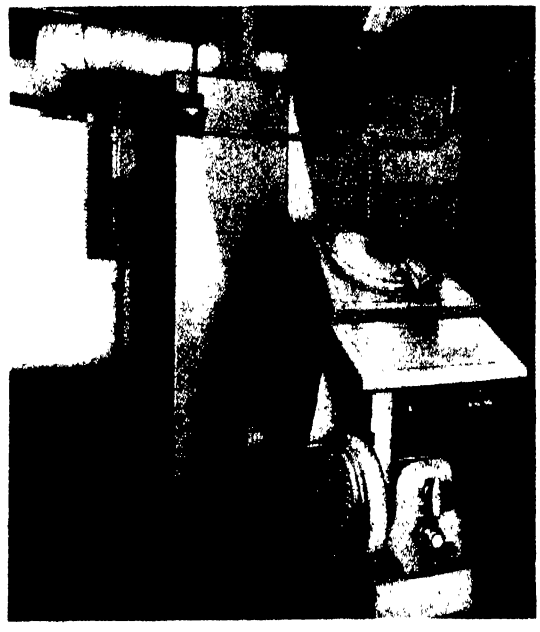
It is a phenomenon of radiant heat that it warms objects without heating the intervening air; therefore the occupants of a room can be made comfortable by radiant heat although room temperatures may be low. Under actual conditions this is just what happens, and an experiment conducted in one of the country's large electrical laboratories is worth relating as dramatizing this peculiarity of radiant heat.

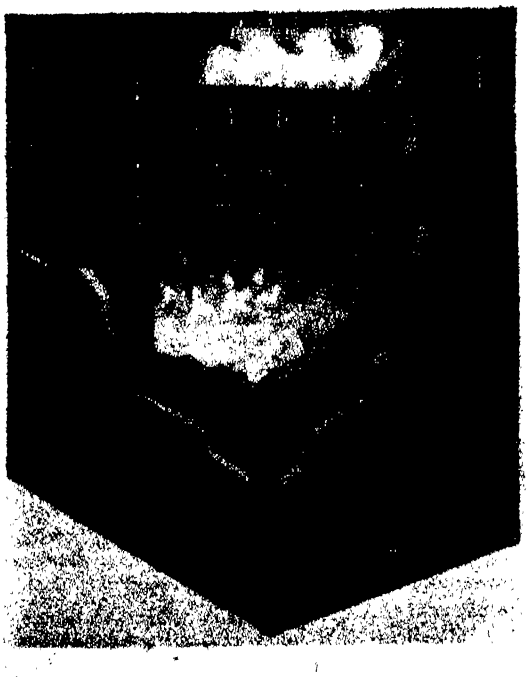
To demonstrate the difference between convected heat and radiant heat, people were seated in a room in which the temperature was 104 degrees, Fahrenheit, and the wall temperature 57 degrees, Fahrenheit. They were asked how they felt and they replied that they were far from comfortable in such a chill surrounding. Then conditions were altered to give a room temperature of 25 degrees, Fahrenheit (below freezing), and a wall temperature of 81 degrees, Fahrenheit. This time the occupants found themselves very comfortable.

Such an experiment makes us more conscious of the law that heat energy can travel only from a hotter to a cooler body and it also drives home the fact that no heating system ever put heat into a person. It shifts attention from consideration of room temperatures to consideration of walls and forces a re-statement of the purpose of heating which is nothing more nor less than the prevention of dissipation of bodily heat at a faster rate than it can be generated. The ideal heating system, therefore, is one which will give the greatest degree of comfort when taking into consideration the loss of heat from the human body by radiation, convection, and evaporation.

Proponents of radiant heating claim that their system is superior because it permits comfort with low room temperatures. They say, further, that radiant heating simplifies the problem of maintaining normal conditions of humidity. Certain examples of European installations forcefully confirm these contentions. There are schools where the classrooms lack one exterior wall and the pupils sit comfortably in outdoor air; there are also hospitals where the patients lie in bed exposed from the side



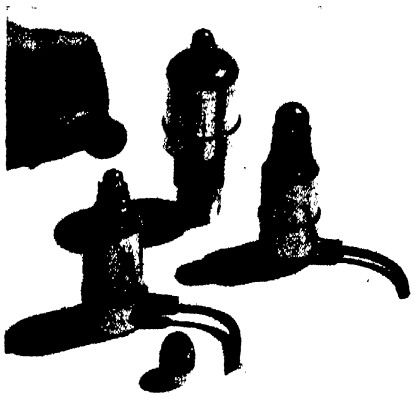




Top: **The fore-runner, still quite new, of a type of domestic oil furnace which has brought many changes in house heating recently**

Center: **An automatic coal burner installed in a home furnace and air conditioner**

Bottom: **Cut-away section of a new oil-burning boiler showing insulation of jacket, water chamber, flue, and the hot water supply coil**



Radiator vent valves with adjustable vent for controlling the amount of steam to each radiator in a system

to the open air yet thoroughly warmed by radiant heat. In neither instance is there any attempt made to warm the *air* surrounding the occupants.

There are several methods of heating with radiation in use today. There is one which employs pipes, imbedded in the ceiling, through which warm water is circulated. There is another which uses plates heated with steam, affixed to or recessed in the wall surfaces. A third method utilizes electrical resistance coils, but its application is limited to regions where electrical current is cheap.

IN the system which employs coils, the pipes are looped back and forth over the ceiling area. Above the pipes is placed heavy insulation, usually cork, while the pipes themselves are placed in intimate contact with the concealing plaster surface. This plaster surface serves as the radiating panel. Ceiling installation is advocated because the rays envelop the occupants of a room. When side walls are used as the radiating surface, all four walls must be radiant; otherwise suitable reflecting surfaces must be had if the occupants are to receive the rays from all directions. Obviously, whether pipes or steam-heated panels are used, care must be exercised to afford direct rays or reflected rays. Radiant heating does not require any supplementary system to warm the air because the air picks up enough warmth from the heated objects to safeguard water pipes, food, and so forth.

There is much to be said for the lower room temperatures which are a feature of radiant heating. We have all experienced the unpleasant sensation of a dry, overheated atmosphere and we also know how much better we feel in a cool and relatively moist surrounding. Temperatures as low as 60 degrees, Fahrenheit, are compatible with comfort in a room heated with a radiant system, and the shock experienced by going outdoors is materially lessened.

While there is much controversy raging over radiant heating, the disagreements are mainly over what constitutes a satisfactory system. Architects, engineers, and builders are in general accord as to the soundness of the principle, but they are by no means one in believing that the ultimate system of radiant heating has been perfected. The panel system, which employs ceiling pipes, is wholly satisfactory to some designers, while others hold that it is only a step on the way. Presumably the principal drawback to its adoption is one of cost, installations running anywhere from 10 to 40 percent higher in outlay than orthodox systems. But since operating costs are claimed to be lower with radiant heating, the disadvantage is not as great as first cost indicates.

On this side of the Atlantic a good deal of experimental work is being carried on covering many phases. At one of the large universities, scientists are trying to determine the physiological effect upon the human body, believing that radiant heating may reduce respiratory troubles. Another experiment seeks to prove the practicability of heating hollow walls with hot air, while some electrical equipment concerns are working with resistance coils imbedded in panels to serve as radiant wall surfaces. Still in the realm of fantasy is the idea of using the sun's rays and supplementing with artificial rays on cloudy days, while even more remote is the conception of heating with induction coils which would *induce* heat in the occupant of a room.

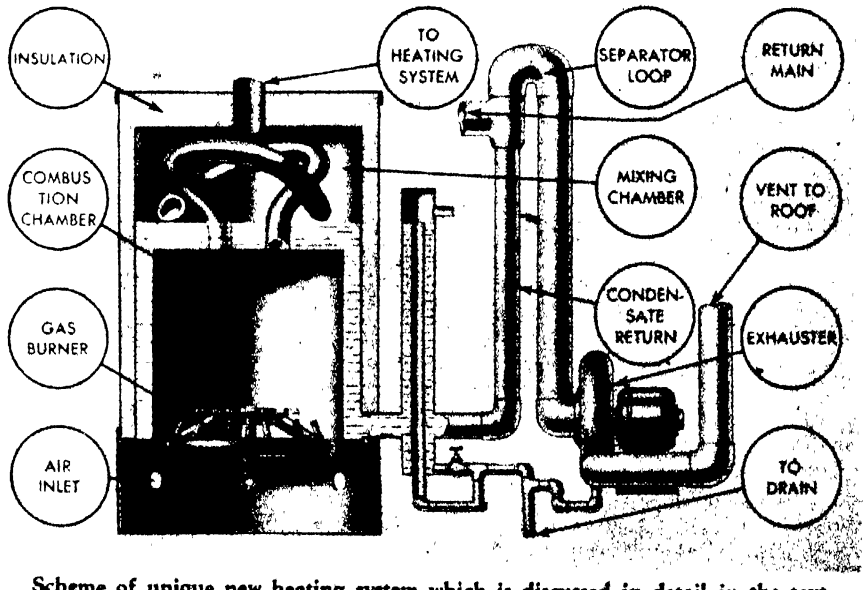
There is no question but that radiant heating is here to stay, but adoption is hindered by costs, whatever the method employed. Some of its proponents believe that it will be used in commercial structures before it comes into general home use. They reason that operating costs, more than offsetting higher installation costs, will make it a sound venture. For the most part electricity is favored as the source of heat, but this is now impractical because of rates for current.

Adoption of radiant heating would have a profound effect upon present concepts of insulation and air conditioning. It would void much that has been done during recent years. With lower room temperatures the diffusion of heat through wall surfaces is much less rapid and construction might be lightened substantially. The problem of humidity control would also be of less moment.

THE point may be raised that radiant heating will not answer the problem of summer cooling or provide a means for lowering relative humidity. In this respect it does not differ from existing systems. The coil system of panel heating does afford a means for circulating cool water through a house and this would be quite adequate for summer comfort in a region where the air is naturally dry. Where humidity is a serious problem some means would have to be supplied for removing moisture from the air, otherwise water-cooled pipes would cause condensation.

What radiant heating has accomplished beyond its own practical attainment is the injection of some new and valuable ideas into the whole problem of heating. And coming as it has when insulation and air conditioning are being studied as never before, the possibility of better heating systems is measurably greater. The ultimate goal is the attainment of comfort with the simplest possible system, and radiant heating may prove to be what we have been seeking.

Photographs courtesy: American Radiator and Standard Sanitary Corp.; C. A. Dunham Co.; General Electric Co.; Iron Fireman Mfg. Co.; and L. L. Munier.



Scheme of unique new heating system which is discussed in detail in the text. The hot combustion gases pass through a mixing chamber directly to radiators

UNDERPINNING TRINITY

Trinity Tower Was Subsiding . . . Old Foundation Extended to Bedrock by Monolithic Piers Through Quicksand . . . Pneumatic Caissons Used

By R. G. SKERRETT

THE massive masonry tower of famous old Trinity Church, which faces Wall Street from the west side of Broadway, in downtown New York City, is now, after 90 years of service, at last supported by the deep-lying bedrock. This recent engineering achievement was put through to prevent the tower from settling more and more and tilting increasingly towards the north and east. The task was a ticklish one and called for very careful work after deliberate preparation.

The combined height of the tower, spire, and cross is 280 feet 5 inches. The tower rises from a foundation of rubble masonry, with a central core of concrete, and that basic structure extends 12 feet downward from the ground surface. The total weight of the foundation, tower, and spire is 11,900 tons, on an area of about 2500 square feet, and is supported by coarse sand and gravel.

Years ago a subway was dug under Broadway close to the tower's foundation and considerably deeper than that structure. Years later, another subway was excavated beneath Trinity Place and close enough to the western or rear walls of the church to cause some settlement of that section of the structure, but support was provided by shifting the load to tubular piles that were jacked down to the deep hardpan and filled with concrete. Marked subsidence and tilting of the tower followed the erection of the two high office buildings directly opposite the front of the church at the neighboring corners of Wall Street and Broadway.

The first signs of trouble were fissures in the masonry over windows in the east wall of the body of the church, north and south of the tower; but the tower itself, because of its thick walls and massive foundation, remained unimpaired although it was moving bodily and settling. A survey quickly revealed that the tip of the spire was 17⅛ inches out of plumb to the eastward. Corrective steps were taken in hand as soon as it was practicable to do so, but the conditions controlling underpinning operations imposed skilful planning.

The sand-and-gravel stratum immediately in contact with the tower's original foundation is succeeded by a 10-foot layer of fine sand and soft, moist clay, that extends to the ground-water level. Below that there is a 24-foot bed of quicksand, a blanket of hardpan from 12 to 15 feet thick, and then bedrock. It was evident that the underpinning could, therefore, be done only with the aid of pneumatic caissons.

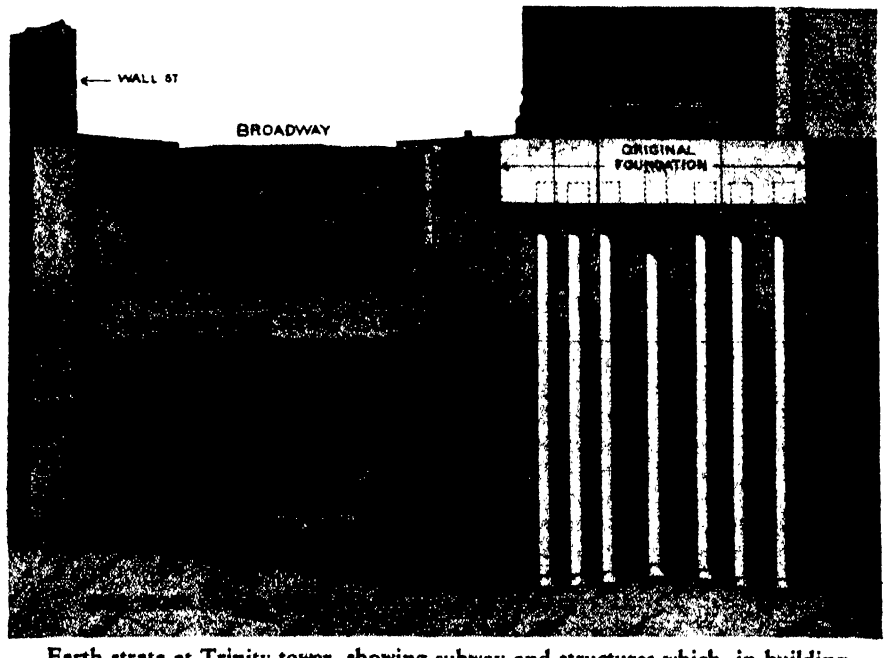
THE steel cylinders forming the shell of each of the 16 underpinning piers are made up of unit sections 42 inches in outside diameter and 49 inches long, with walls one half inch thick. An inside flange at each end of a section made it possible to bolt to it connecting sections; as the cutting edge of the caisson was forced deeper into the ground, another cylindrical section was added at the top where two 100-ton hydraulic jacks thrust upward against the tower masonry and downward upon the steel section. The caisson and cutting edge was made up of two of the cylinders to form a working chamber for a single sand hog, and immediately above it was an air lock.

The man in the working chamber cleared away the soil a pailful at a time, or he dug away the material beneath the cutting edge to allow the caisson to settle deeper. The man in the air lock lifted the pails of muck until he had several in his compartment. Then the door in the air-lock floor was closed, the air pressure was lowered until it fell to that of the atmosphere, and finally, the man opened the door over his head and hoisted the loaded buckets to the surface.

When the cutting edge was a few inches above bedrock, the rock surface was cleaned and a layer of concrete was placed on which to set steel members as a permanent seating for the cutting edge. The lower part of the steel casing was then plugged with concrete to a height of six feet. When that had set, air pressure was released, and the tube was filled with concrete to produce a reinforced pier. When once a caisson was started on its journey downward to bedrock, it took about four days to force it to its landing on the ledge.

The work of underpinning Trinity tower was carried to its conclusion within an area so restricted as not at any time to interfere with the regular services of the church. Skilful engineering made this possible.

The entire job cost approximately 100,000 dollars.



Earth strata at Trinity tower, showing subway and structures which, in building, disturbed the underground natural balance. New tower foundation is shown

NATURE'S AIRPLANES

By S. F. AARON
Illustrations by the author

IT is said that the Wright brothers lay on their backs for hours upon the sands of the North Carolina coast, watching the soaring flight of turkey vultures, or buzzards, as they are most often called. Much may have been learned from these great birds, for no winged creatures, excepting the famed albatross and perhaps the swallow-tailed kite, can show such remarkable staying powers on motionless pinions.

Because of its aerial evolutions the buzzard's flight has been called the poetry of motion, dividing this honor with the vastly different progress awing of the swallows. As is well known and often observed, it is not uncommon to see turkey buzzards, with a moderate gain of necessary momentum from a half dozen or so of powerful strokes of the wings, wheel in wide circles (Figure 1) and gradually ascend to several hundred feet without further effort than to take advantage of air currents, or, when these currents are not to be encountered, make an occasional dip downward at perhaps five degrees. At other times, when a certain direction is to be maintained and the currents are not propitious, added wing strokes are indulged in.

Alexander Wetmore, in *The National Geographic Magazine*, makes the statement that on calm days turkey vultures are loath to take to the air. This is an error. On days when flags hung limp on high poles and high overhead cumulus clouds could not be seen to move, I have observed these birds in considerable numbers cross the sky in great spirals and without effort. [Motorless glider planes are flown by seeking the upward currents beneath cumulus clouds.—*Ed.*]

MOST birds soar on motionless wings at times, as may most often be observed of those species larger than a robin: the grackles, meadow-larks, bob-whites, doves, and the many shore and water birds. Few of the smaller species, with the exception of the purple martin, at times the chat, the bobolink and the chimney swift, practice soaring. Many of the medium-sized and larger birds of strong flight rarely or never indulge in it —for example, the snipe and plover, the willet and curlew and kingfisher. The crow, the grouse, the true partridges, the mourning-dove and band-tailed pigeon, the ducks and the herons, adopt a slower advance on fixed pinions generally when approaching the spot where they mean to alight. The hawks and the larger owls possess the same habit; the osprey and the slow-flying buzzard hawks, like the red-tail, soar at times when in direct flight, or when desiring to make a closer inspection of the earth. This is true also of such water birds as the cormorant, the frigate-bird, the awks and their kindred, but he who sees a gull or tern advance on motionless wings has witnessed a rare sight, indeed.

Among the small birds, such as the warblers, finches, wrens, fly-catchers, orioles, shore larks, vireos, and so on, soaring is rarely or never practiced.

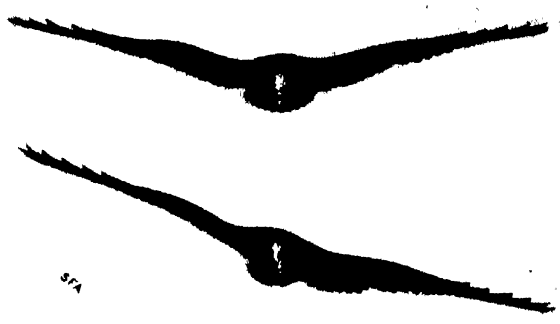


Figure 1: **A soaring turkey vulture. *Above:* Straight ahead. *Below:* Wheeling to the bird's left; the wing on the inner curve set to cause a greater resistance**

With these, their light weight, relative to muscular power, is such as to make the chief effort of being sustained in air an easy matter. The same applies to the smaller bats and, of course, to the insects. Rather odd it is, therefore, to see some of the larger butterflies and moths soaring across beds of flowers, or through the moonlit woodlands. All other insects know progression in the air only by constant and rapid wing motion. And this may also be said of the dragon flies (the order Odonata), which have their anterior wings placed a little ahead of and above the posterior pair. This construction would seem to have been the model for the biplane (Figure 2). It might be expected, considering the rapid and often constant flight of these creatures, that they would gain some respite from intense activity by soaring at intervals.

The principle of aerial propulsion is well known and easily understood, yet certain misconceptions have arisen respecting it. There seems to be a common impression that, to gain a forward motion and speed, the downward stroke of the wing is also directed backward, thereby affording a greater driving force. Such direction, however, never

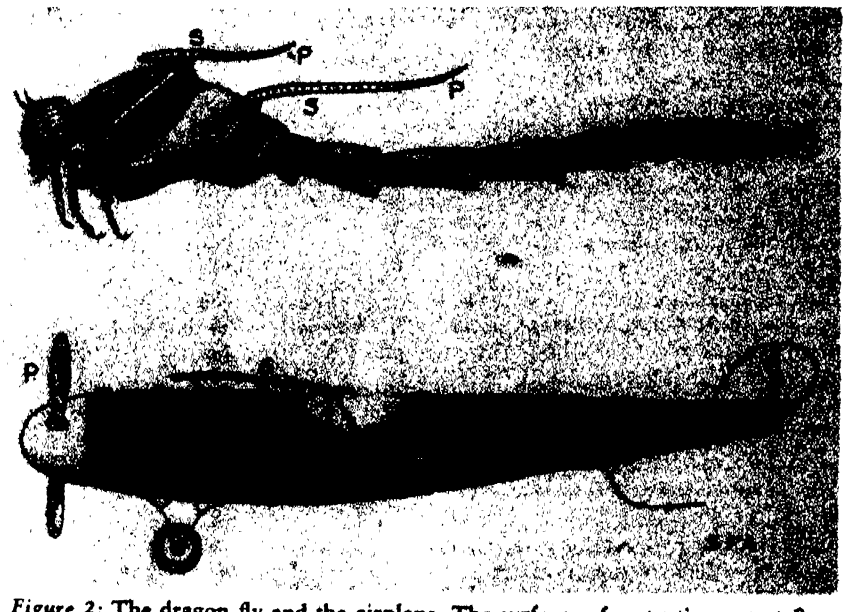


Figure 2: **The dragon fly and the airplane. The surfaces of sustention are at *S*, those of propulsion at *P*. The insect has no rear stabilizer or rudder. Its weight is proportionally less, its wing expanse and abilities as an aerial acrobat greater**

occurs; in all flying creatures the wing strokes are exactly at right angles to the line of flight, and propulsion is due entirely to the construction of the wing, which insures a slanting resistance to the air that serves to cause a forward momentum, exactly on the principle of the airplane propeller blades.

The rigid attachment and the muscular control of the wing anteriorly, and its posterior pliability which permits a limited upward slant in the downward stroke so as to drive the air backward, serve to drive the creature forward. In the upward lift of the wing this pliability permits the wing to come up edgewise and constitutes in all flying creatures an automatic control.

This same action is apparent also in the flight feathers of birds (Figure 3). The broader vanes give upward in the downward stroke and come into contact with the shorter anterior vanes, making a resisting surface, but in the upward lift the round quill pivots in its socket to let the air through the vanes thus separated. With the bats and the insects the pliability of the entire wing is sufficient to give the necessary slant for the forward motion and the lift.

Figure 3: Top: **Flight feathers of a bird's wing.** *Center:* **A section of the same, with the posterior vanes braced against the stiff anterior vanes.** *Bottom:* **Sections during upward lift of the wing, with the feathers pivoting on round quills**

The principle of soaring is also simple and is easily demonstrated by tossing a card—or other light, thin object—edgewise, its plane surface not necessarily entirely flat, but parallel to the earth and at right angles to gravitation. That is about all there is to it, except that the wings of soaring birds are somewhat adjusted to meet with varying wind currents, as may be best observed in the turkey buzzard as seen from a mountain top or dead tree-top close to a roosting place. This adjustment of the wings seems to have escaped observation, or at least recording, though the Wrights and others must have at least surmised it; hence the warping wing tips and ailerons used on airplanes from the first.

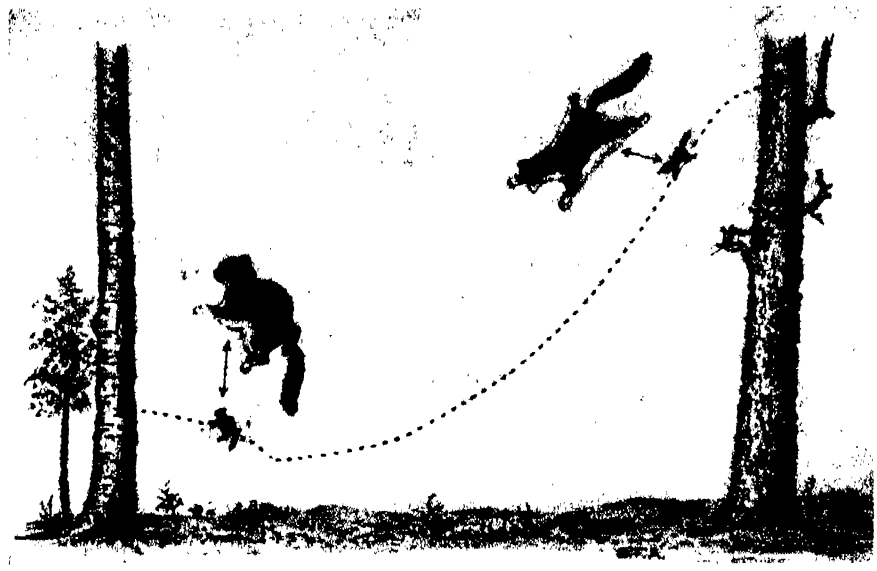


Figure 4: **The flight of the flying squirrel. The knowing little fellow sets himself in resistance to the air when near his goal, and is suddenly elevated from the downward or level course. The larger drawings show the attitudes represented**

NOT having a revolving propeller to give forward motion, the soaring bird depends upon its wings to give it momentum. This, of course, is a distinct advantage that can hardly be put into practice on airplanes. The chief function of the wings is to sustain the creature in the air; propulsion follows, automatically.

When a soaring bird wishes to rise or wheel it is not the tail alone that performs these deliberate turns; the wings are altered in relation to the line of flight. This alteration is no doubt instinctive, as it is when the desire is to hover or check momentum, observed also in such insects as the sphinx moth, many butterflies, the bee-flies and bees, and in the humming-bird. This action is governed entirely by the wing position in the downward stroke, it being such as to check both forward and upward momentum, thus overcoming the effect of the pliable posterior portion. It may also be observed in the hovering of a sparrow-hawk when the swift killer is looking for mice far below. The sudden shift of the wing stroke may be seen through a powerful glass as the bird again goes on, or darts to earth after its prey.

The shifting of the wings of soaring birds is very slight and is difficult to see from the ground below. When wheeling, and often without a very decided movement of the tail, one wing is lowered and held so as to meet with greater resistance, while the other and outer wing on the curve is not altered in the least.

The tail, perhaps oddly enough, plays so small a part in the flight of birds that the observer may readily note a bird that has lost its tail doing various flight stunts as handily as its tailed fellows. The chief purpose of the bird's tail seems to be as a stabilizer and an aid in sustaining the creature when in motion, and no doubt the effort is less when the tail is available. But the bat and swift insects are without tails.

The flying-squirrel offers an interesting example of the art of soaring minus wings, for the stretch of its membranous skin between fore and hind legs can scarcely be used for actual flying—though in case of an unusual fall the beautiful little creature will flap these membranes in order to check the downward velocity and even to carry the animal forward a little to a perch away from danger. I have witnessed this act when a flying squirrel was checked in its flight by a pole thrust upward, and when a red squirrel was shaken from a branch.

Contrary to common supposition that the downward and upward drive of the flying squirrel composes an even curve, attempted photographs (not good enough for reproduction, as was also the case of the buzzard mentioned earlier) distinctly indicate that the final upward slant of the little quadruped is effected by dropping the hind legs so as to cause the membrane to present a greater resistance and to pitch the squirrel almost suddenly upward (Figure 4). In the longest dives, rarely over 150 feet even from the highest trees, this upward curve may begin at least ten feet from the place of landing and lift the soarer three feet higher. On this principle very strong wind currents will lift a turkey vulture several yards if the bird sets its wings for the purpose.

The Beginnings of Pottery

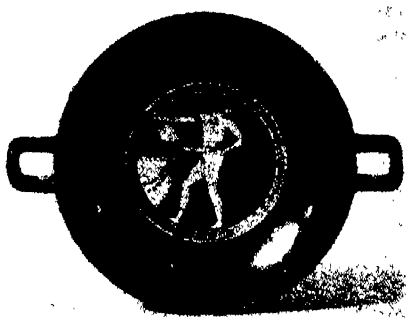
Spilled Stew Gave the Cue . . . Centuries Before the Potter's Wheel . . . Made Commerce More Profitable . . . Opened Many Fields of Art

By JOTHAM JOHNSON
University Museum, Philadelphia

NINE thousand years ago this morning, more or less, a neolithic villager squatted at a smoking hearth outside his hut, preparing a savory stew. His cooking-pot was the hollowed-out lower half of a large gourd, blackened by previous encounters with the flames. His unhappy task was to keep the gourd near enough to the shifting blaze to boil the stew, but not close enough to burn it out.

Presently a crack opened down one side of the gourd and the juice dribbled out in a hissing cloud of steam.

New Stone Man had already used wet clay to hold together the reeds and branches of his primitive roofs, so a new idea struck the cook. Chattering angrily to himself, he grabbed the gourd and daubed the crack with a handful of mud from the road, and in anticipation of further cracks smoothed a thin layer of mud all over the gourd.



Interior of a cylix, or drinking cup, in Attic red-figured style. A whole lesson in Greek painting is here. The youth, holding a cylix of similar shape in his left hand, is about to fill it with the oinochoe, or pitcher, which he holds in his right, from the crater, or mixing bowl, at left. This cylix is now on view at the University Museum, Philadelphia

The remains of the stew were pretty dry. He slopped in more water, out of another gourd, and grimly placed it back in the flames. When the stew was done he lifted it from the fire and found himself unexpectedly the owner of history's first clay pot.

The potter's wheel was centuries in the future. At the start it was simplest to mold vases around gourds, the natural models so familiar to primitive man. We have not discovered the first vase ever made but sites in Macedonia and elsewhere have yielded from below all other human traces specimens of cups and small pots in the shape of the bulbous lower end of a squash.

Clay and fuel were to be found everywhere and it was soon realized that the shapes and uses of pottery were practically unlimited. The excavations of the last decade, at a wide range of sites, have thrown new and stronger light on the spread of the new industry from one end of the eastern hemisphere to the other. Every human activity was expanded and facilitated as by no other single invention. The surprised cook received a variety of cook-pots with lids and without; also ladles, tripod supports, strainers, trays and jars for grains and liquids. Beer was discovered when a certain combination of grains left standing in water made a palatable drink, and one of the earliest (c. 4000 B.C.) seal-impressions found by Mr. Charles Bache at Tepe Gawra shows two men at work stirring some such mixture. Wine resulted from the first attempt to store grape juice for the winter. Table service was improved with cleaner plates, pitchers and mugs, and "flat silver" was not neglected, though here pottery was of little use; the knives were of stone or flat splinters of obsidian, the forks had only one tine, not unlike nut-picks, and the spoons were flat bone spatulas.

LITTLE milk jugs were made with nipple spouts to feed Baby, and decorated with small representations of the human breasts they replaced. Toy sheep and cattle lent plausibility to children's games of Thieves and Shepherds. Terracotta dice started mankind on the endless road to ruin, and his enemies broke his skull with clay slingstones and maceheads. Farmers stored their next year's seed more safely in clay storage jars, and shallow dishes with wicks hanging over the edge made simple lamps for winter evenings, but agriculture and the household were not the only gainers from the "invention" of baked clay. Terracotta spindle whorls and loom weights made spinning and weaving easier, and vats for dyes opened new fields of conquest. Tanks for tanning fluid were a boon to leather workers. As men's needs expanded, increasing interregional commerce depended heavily on agents and messengers, who used clay impressions of their principals' seals for identification. The seals themselves were of stone or bone, or more likely still of clay; and they and their impressions constitute our only approach to man's first artistic impulses.

With such cheap "letter-paper" as clay at hand, writing was not long in making its appearance. Messages and instructions were worked on clay tablets; pictographs must have done very well at first, but cuneiform script was destined to supersede them. When these tablets were baked they were practically indestructible; but seeking a still more forgery-proof form of contract ancient man enclosed them in clay envelopes on which he wrote a brief summary of the terms. If any dispute later arose the outer coat could be broken and the original examined by the contracting parties and the indispensable witnesses.

Commerce became more profitable when perfumes, oil, wine, and other liquids were shipped in terracotta jars instead of skins or pipes, on animal back and by boat; adequate water-jars made the first navigators less timid of the sea.

Through the following centuries religion was to make the most of the pos-

"Slipper" coffins, in green-glaze pottery, found in the Parthian cemetery at Nippur, Mesopotamia, by a University Museum Expedition

sibilities latent in the new medium of baked clay. Vessels and ritual instruments for use at the altar were manufactured, none more elaborate than those of Palestine and Crete. Figurines reminded gods of their worshippers and worshippers of their gods. Continual reminders of their interests, barge-owners set up before their guardian divinities model boats of clay, caravan drivers set up "covered wagons" and clay camels, loaded or bare, vintners dedicated wine-jars and warriors swords, shields and chariots; and the gullible sick set up little models of afflicted hands, eyes, ears, and intestines—a practice by no means extinct today.

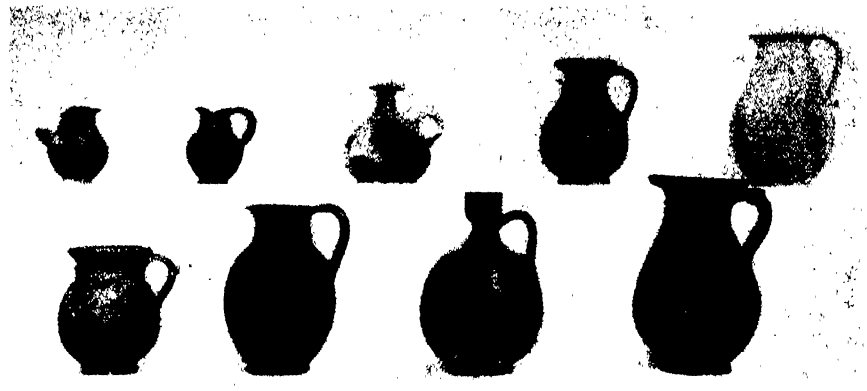
Dr. Ephraim A. Speiser's excavations at Tell Billa in Mesopotamia yielded a small Hurrian shrine, now in Philadelphia, made of tiny clay bricks set in pitch. The Greeks made charming terracotta scenes of worship, and apotropaic plaques to ward off the Evil Eye and other unwelcome visitors. The Romans made model temple façades in one piece, and cheap incense-burners and family-size altars for household use; at Minturnae, in the refuse-heap of a vast potter's shop, I found two broken clay tomb markers.

All over the ancient world storage jars formed handy coffins for the dead, the smaller sizes serving for children and

Fragment of seal impression on clay from "Round House," Tepe Gawro

babies and the smallest urns for ashes, where cremation was practiced. Of course so admirable a material for real coffins could not be overlooked, and you may be sure that the early painted terracotta sarcophagi from Clazomenae in Ionia, the Etruscan ones which show the departed reclining on couches with their wives, and the green-glaze slipper coffins in vogue among the Parthians, are conspicuously displayed in the museums lucky enough to have them.

On the whole, architecture gained most of all from the discovery of uses for clay, though primitive man was very slow to take the hint. For centuries, as we saw, he used wet clay to bind the boughs and rushes of his roofs, and often his walls were of the same material. When these burned the clay was baked more or less rigid, in some cases pre-



Specimen jugs and pitchers from the "Potter's Shop" at Minturnae

serving its shape through six millennia to be found by modern diggers. Nevertheless it was long before burned bricks gained a popular foothold, and they have never completely superseded sun-dried mud bricks in Western Asia and Greece. Yet one of the earliest uses of bricks was in architectural decoration, when the builders of Babylon's Ishtar Gate molded and glazed their exposed edges to depict monstrous dragons and chimaeras.

Sir Arthur Evans' explorations at Cnossos have disclosed the Cretans as the first patrons of good plumbing. Their wells and reservoirs, their practical conduits, their terracotta tubs and tile-lined baths and well-fitted subsoil drains are as celebrated as Minos' great storehouses and bright stucco walls. Most Greek cities placed intellectual above physical comfort but Olynthos in Northern Greece, as Dr. David M. Robinson has found, was very advanced in the matter of sanitation. The Romans carried this a few steps further when they built their great baths, heating the water and warming the rooms by blasts of hot air conducted through walls and floors built of specially designed hollow tiles.

Flat tiles of terracotta proved to make an almost perfect roof. They were (and still are) cheap to make and lay; they come and go in temperature extremes like shingles or slate and unlike sheet metals; they can be taken down for repairs and replaced, or sold for reuse second hand; they permit enough ventilation to save the rafters and sheathing from dry rot; and they are utterly unaffected by weather. Today they are relatively light, but in antiquity their tremendous weight was one drawback, making transportation costs high unless they were manufactured locally, and requiring massive construction under them. Yet such were their advantages that during classical times men hardly bothered to experiment with substitutes, except when out of vanity they roofed their temples with marble copies. When the roof tiles fell and broke, the Romans built the fragments into their concrete walls like so many bricks; broken pieces of the great Roman dolia or storage jars served the same purpose, until the demand exceeded the breakage and the Romans were forced into commercial manufacture of real bricks.

But if tiles made satisfactory roofs, it might also be possible, as the Greeks perceived quite early, to face exposed wall timbers with them too. Waterproof paint was not known, the earth washes of the time providing only short-lived surface color. Accordingly, they nailed flat plaques of terracotta to their architrave beams and friezes. At first these were merely painted, but Hellenic instinct for decoration soon molded three-dimensional designs, adding depth and the play of light and shade to color. The Etruscans took over the architectural terracottas of the Greeks but it remained for the Romans and their Italian kinfolk to extend their use to the furthest limit. Eaves and pediments, even door-jambs broke out in a flutter of gay colors. Special fluted sheaths were made for wooden columns, with suitable bases and Ionic or Tuscan capitals. And the molds in which all these were cast were also of terracotta. Terracotta objects are fragile but the smaller the fragments the less easily they break. Except that time and water have eaten some away, the fragments of every vase ever made still exist for archeologists to find and understand.

IN the course of history men forgot their simple beginnings. With no rational explanation of the source of fire, the shimmering imaginations of the Greeks wove to satisfy their children's curiosity a sober story of a superman Prometheus, an older Christ who gave his life for mankind. He stole a bit of the sun's fire, showed his fellows how to cook their food and warm their chilled bodies, and demonstrated the simple chemistry of firing pottery and smelting copper. The gods chained him, an object lesson, to a Caucasus crag and left a vulture to gnaw his vitals.

So the old story. Even though Man had fire from the beginning, ever since the first cave-dweller dragged home burning branches from a lightning-set forest fire, and though pottery and metals were discovered a thousand or two years apart, Prometheus is as good a name as any for Man's greatest benefactor.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

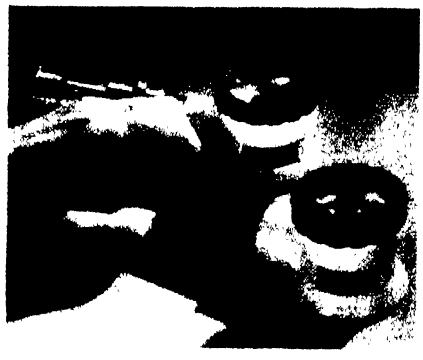
Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER
Chemical Engineer

Illuminated Magnifier

PROFESSIONAL men, police departments, stamp collectors, bankers, purchasing agents, textile men, mechanics, and manufacturers of all products requiring close surface inspection have found use for a new illuminated magnifying glass recently placed on the market. Giving five-power



Magnifier with a built-in light source for illuminating surfaces

magnification with illumination of the field of vision, the new "Flash-O-Lens," made by E. W. Pike & Co., employs a double lens system.

The Flash-O-Lens is formed with a screw socket to one side of the lens barrel. Into this socket may be screwed a special battery case resembling a flashlight, in which are used standard flashlight batteries. A light projects into the space beneath the lenses to illuminate the work being studied. Extra equipment consists of an adapter to use, for the same purpose, current from the light circuit through an extension cord.

An accurate spacer ring of Bakelite holds the lenses in exact focus, while a white composition frame is employed to reflect the light. A side opening in the frame makes it possible to use instruments or a pencil while examining an object.

Improved Sulfur Cements

BY dissolving small amounts (up to 10 percent) of polysulfide rubber in sulfur cements, their resistance to mechanical and more particularly to temperature shocks is greatly reduced. Without this addition, sulfur cements go through a process of crystallization with changes of temperature, and very soon crumble. The addition of polysulfide rubber, a synthetic rubber-like material, apparently reduces this tendency to crystallize and greatly increases the usefulness of the cement. Sulfur cements are particularly valuable in bonding acid-proof tile when used to handle corrosive chemical solutions. They have also been used to bond brick paving of automobile roads.—*D. H. K.*

WAXED COAL

SOFT coal dust in the home has always been such a problem that a new process has been worked out for waxing coal to prevent the nuisance. The treatment is said to be permanent and the wax is non-volatile and non-spreading so that no odor develops in the basement and the floor is not oiled nor discolored.

Sulfurous Acid Preserves Cut Flowers

AT a cost of less than half a cent for each pint of water in which they are placed, cut flowers may now be kept fresher and more vigorous for longer periods of time before they wither and die. Experiments conducted at the scientific laboratories of the Hawaiian Sugar Planters Association in Honolulu, indicate that two eye droppers full of sulfurous acid (not sulfuric acid) added to each pint of water encourages buds to continue growing and leaves and stems to remain greener, and permits the flower itself to retain its freshness in some cases for days after it would normally cease to be attractive.

Sulfurous acid can be bought in pint bottles at almost any drug store at a cost of less than one dollar; one pint of the acid will serve as a cut flower preservative for more than 200 pints of water at the rate of two cubic centimeters of acid for each water pint; the average eye dropper has a capacity of one cubic centimeter.

Astonishing results have been obtained in some instances. The Hawaiian Sugar Planters' scientists have carried the experiment far enough to note that large-stemmed flowers, such as lilies, hydrangeas, chrysanthemums, gladioli, rhododendrons, and the like are more benefited than the delicate, smaller-stemmed varieties such as daisies, snapdragons, carnations, and so on.

"This," say the scientists, "is evidently because the vital forces stored by nature in the small-stemmed flowers are not great and become exhausted quickly. When they are gone the flower is finished. The larger stemmed varieties, however, have in some cases given us fine results. Hydrangeas have lasted four and five days longer than normal when the sulfurous acid was added to their water."

The scientists ask that the sulfurous acid treatment not be regarded as a fool-proof method of preserving all cut flowers, but do state it has been found more effective by and large than any of the hot water, aspirin, or other methods now used by florists. It is not to be expected that flowers which bloom but one day under normal conditions in the garden will bloom for longer periods after being cut. However, those of long life on plant or bush but which die in a day after being cut will be aided by the addition of sulfurous acid to the water in which they are placed.

All flowers given the solution should be watched and if the stems indicate they are being burned, less acid should be used; in

Pan-Pacific Press Bureau

Wilted hydrangeas, right, and a bunch preserved with sulfurous acid

all cases a weaker solution, about one eye dropper of acid per pint of water, should be used for the more delicately stemmed flowers. Blooms that last for more than two days should have fresh water and solution given them. Home experiments should be made to determine what local flowers are benefited most by the sulfurous acid solution because different soil qualities in different localities may have some bearing upon the solution's effectiveness. Experiments along this line have not been made by the Hawaiian scientists. Special care must be taken not to confuse sulfurous acid with sulfuric acid which will kill the flowers.

FUNGI

WALCHA in New South Wales, Australia, claims a giant mushroom five feet two inches in circumference, 11 inches high, and weighing 17½ pounds.

R. M. S. "Queen Mary" with Removable Decks

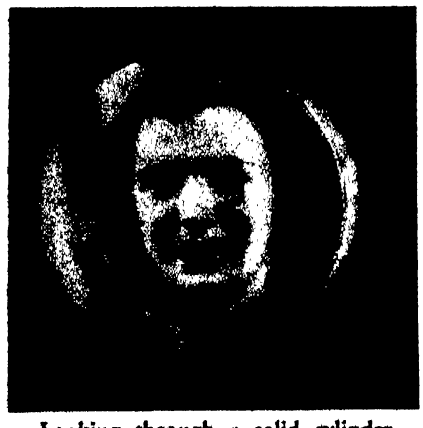
TOYS do not usually find a place in this department, but the one shown in our illustration is so unusual that it will appeal as much to fathers as to sons. Made and sold by The London Electrotype Agency, Ltd., England, this model of the beautiful new *Queen Mary* is made of layers of heavy cardboard which may be swung around a pivot to expose the various decks. On each layer is the complete plan of the corresponding deck, there being 12 such removable decks. The deck plans were designed by G. H. Davis, the noted artist of *The Illustrated London News*. The length over-all of the model is 12 inches.

Model of the *Queen Mary* built up of cardboard strips to show deck plans

New Transparent Resins

A NEW series of synthetic resins clear as optical glass are described as being strong, flexible, and non-shattering. These resins, polymers of the esters of methyl acrylic acid, are thermoplastic; that is, soften when heated, and can be sawed and machined. They are being marketed under the trade-name "Pontalite." In describing them before the American Chemical Society, H. R. Dittmar said: "The transparency, strength, high softening temperature, low specific gravity, and chemical resistance of polymethyl-methacrylate make it an outstanding plastic material of either the cast or molded type. The unusual clarity of this resin permits its fabrication into delicately tinted shades. With the combined use of dyes and pigments, materials of varying degrees of color and transparency have been prepared. The value of this resin is greatly enhanced by the ease with which it can be worked, engraved with unusual effects, and cemented to itself to give joints which for all practical purposes are as strong as the resin itself.

Objects made of Pontalite. Note the delicately carved surfaces on some



Looking through a solid cylinder of Pontalite, 9¼ inches in depth

"The glass-like transparency of these resins suggests many uses as glass substitutes where strength, lightness, ultraviolet transmission, and ease of fabrication by molding are desired. Their substitution for glass in certain fields is facilitated by their remarkable chemical inertness. Among the many uses which have been evaluated and patented in the plastics field are safety glass interlayer, sound-recording records, dentures, and telephone and radio transmitter diaphragms. The low viscosity of the monomeric esters of methacrylic, together with the ease with which they can be polymerized, adapt them as impregnating agents.

"The dielectric properties of methyl methacrylate resin make it of value in the electrical and instrument field. These resins are used as textile sizing and stiffening agents. Their clarity, light resistance, water impermeability, resistance to alcohol, oil, alkali, and acid, and general compatibility suggest many applications in coating compositions and varnishes."—*D. H. K.*

Soap to Match the Bathroom

SOAP made by a new process which requires a few minutes instead of many hours for completion is being marketed in colors which match the modern trend in bathroom design. Black, blue, red, green, brown, and gray are among the colors available. The trick has been to choose dyes which will color the soap but not the suds or the user.—*D. H. K.*

Squash-Pumpkin Hybrid

THE production of about a dozen fruits from more than a hundred cross pollinations between different varieties of pumpkins and squash made at the State Experiment Station at Geneva, New York, has thrown considerable light on the botanical relationships of these groups and, incidentally, has given rise to several new forms that seem to be either immune or highly resistant to squash mosaic. Many unsuccessful attempts to hybridize these two vegetables have been made during the past century, hence the success attending the Station trials is being watched with con-

Trawler *Storm* has a fish-hold lined with pure nickel sheets

siderable interest because of the many possibilities it holds for developing new and better varieties.

"Cucurbita is the technical name for pumpkins and squashes of which three annual species are more or less commonly grown," explains Prof. Van Eseltine, Station botanist. "These species are known as *maxima* which includes the winter squashes, such as Hubbard, Boston marrow, and related types; *moschata*, also known as the grammas and best illustrated by the Japanese Pie, Winter Crookneck, and the like; and *pepo*, or the pumpkins, the fall squashes, and the summer squashes or scallops, vegetable marrows, and similar forms.

"In each case, the forms within these groups crossed readily but the groups would not cross with each other. This seemed to establish the specific identity of the three groups. In 1930, an attempt was again made to cross these different groups in a study of the origin of the annual Cucurbitas. About a dozen fruits have been obtained from these crosses and while they present many interesting possibilities, including evidence of marked resistance to squash mosaic, much further study will be required before any very definite conclusions can come from these investigations."

CANNED WINE

NOT to be outdone by the brewers, American wine makers are now marketing their product in cans lined with synthetic resin.

New Type of Trawler

RADICAL departures in the design of fishing trawlers have been achieved in the Diesel-powered *Storm*, built by the Bath Iron Works for the Forty Fathoms Fisheries of Boston. In size, lines, and equipment, this vessel is a striking contrast to the old Grimsby type of trawler which has been standard on both sides of the Atlantic for the last 30 years.

Product of the highly competitive race to supply the American market with fresh fish of high quality, *Storm* is constructed with hull plates twice as heavy as those used in United States Navy cruisers in order to withstand the buffeting of winter seas. Her fish-hold is lined with pure nickel as the last word in sanitation, and a special air-cooling installation will keep it just above the freezing point to permit the delivery of "winter fish" the year 'round.

First of three vessels of this type, *Storm* has been followed by sister ships, *Surf* and *Swell*, which are now in service. Together they cost 600,000 dollars.

A feature regarded by veteran fishermen with almost as much amazement as the refrigerated fishholds is the provision of showers and washrooms for all hands. Other comforts are to be found in improved quarters for officers and crews and drying rooms for wet clothing.

The holds, however, are considered the most radical change. Fishing companies are reticent about the amount of spoilage they encounter in hot weather. In January, loss from this cause is practically nil, but in July, it is admitted, as much as 20 percent of the fish in the old-fashioned holds may reach port as second-grade quality.

The new refrigerating system is designed to eliminate this loss. Between the hull plates and the inner shell of the hold there is a three-inch lining of cork, through which air ducts run vertically. Dry, cold air is thus circulated to keep the hold at a temperature between 33 and 36 degrees Fahrenheit.

This temperature, in turn, controls the rate of melting of the ice in the hold and makes it possible to cut the load of ice which must be carried from 60 tons to 20 tons. This factor alone increases average hold capacity by 100,000 pounds, bringing total capacity up to 400,000 pounds.

The new trawlers are 144 feet, 8½ inches long over-all, and 131 feet on the waterline. They have a beam of 25 feet and are 13½ feet deep. They are so constructed as to be more easily driven through heavy seas in bad weather and as not to be "down by the head" when returning, loaded, from the banks. They will permit longer fishing in bad weather and quicker runs to the market. The stems have a pronounced forward rake with the lines immediately aft unusually fine to permit easy entrance into the water. The underwater lines aft are of cruiser stern type.

The main engines are 17½-inch bore by 25-inch stroke, heavy duty, solid injection McIntosh Diesels, capable of developing 600 horsepower at 180 revolutions per minute.

FOG

LONDON "pea soupers" are made in Hollywood by shooting live steam over solid carbon dioxide (or dry ice).

Really Dustless

ENTIRELY new types of five ton, dust-proof and hygienic garbage trucks with rotating drums are now in use in Gothenburg, on Sweden's west coast. Both the ingenious trucks and the chassis are made in Sweden.

Each truck body is completely enclosed and has a capacity of seven cubic meters (247 cubic feet). The loading is dustless and is made directly from the covered garbage receptacles in the courtyards of apartment houses or factories. When the

One of the hygienic garbage trucks now in use in Sweden

For Christmas

Nothing makes more acceptable gifts than practical books

1. COSMIC RAYS THUS FAR—*By Harvey Brace Lemon.*

A short, compact, thoroughly authentic, popular summary of our present knowledge of cosmic radiation, by a professor who has a flair for popular presentation.—$2.15 postpaid

2. OUTPOSTS OF SCIENCE—*By Bernard Jaffe.*

Superlative reading—516 pages of authentic, up-to-the-minute information on genetics, anthropology, physical disease, cancer, glands, mental diseases, vitamins, insects, matter, radiation, astro-physics, weather, and galaxies.—$3.95 postpaid.

3. UNSOLVED PROBLEMS OF SCIENCE—*By A. W. Haslett, Cambridge Univ., England.*

Covers those unsolved problems of science which are fully as intriguing as the things science has definitely settled—cosmology, geology, meteorology, anthropology, biology, physics, and mathematics.—$2.15 postpaid.

4. THE BALANCED DIET—*By Logan Clendening, M.D.*

The widely known author of many medical features and books gives us here an ideal, popular book on diet—ideal because it is not too technical but not too superficial. A good book for most people.—$1.65 postpaid.

5. FOOD, FITNESS AND FIGURE—*By Jacob Buchstein, M.D.*

A popular treatise on foods, their content and effect in our diet, also on beverages, food fads, vegetarianism, fasting, and weight control. Detailed 14-day diets.—$2.15 postpaid.

6. WHY BE TIRED?—*By Daniel Josselyn.*

Short and to the point, this book should be a tremendous help to all "office athletes" those sedentary workers who work as strenuously as laborers but do not realize it except that they are usually "dog-tired."—$1.10 postpaid.

7. FOR STUTTERERS—*By Smiley Blanton, M.D., and Margaret Gray Blanton.*

Said to be the first book to point a way to the recovery of normal speech through the application of well-tried principles of medical psychology and psychoanalysis. What the individual, the parents, and the teacher can do.—$2.15 postpaid.

8. 1500 NEEDED INVENTIONS—*By Raymond Francis Yates.*

A revised edition of a book published three years ago, expanded to include many additional subjects. Crammed with short, pithy paragraphs describing various desirable inventions in a number of different fields.—$2.65 postpaid.

9. FUN WITH ELECTRICITY—*By A. Frederick Collins.*

Electric phenomena with directions to perform the experiments that exhibit them. Simply written, this book has proved a source of enjoyment and mental stimulation to mechanically inclined individuals. $2.15 postpaid.

10. HOW TO MAKE A GHOST WALK—*By Joseph Dunninger.*

How the so-called psychic mediums perform some of their stunts. Delightfully humorous, it tells how to develop "psychic forces", how to tip tables, produce "spirit" messages on slates, how to read sealed messages, etc.—$1.15 postpaid.

Junior Scientists' Selection

AMONG the welter of new books for children this year, there are a number of excellent ones for the Junior Scientists. Most of those mentioned briefly below are for the ages of six or eight to fourteen; contain interesting facts presented in easily readable fashion; are well illustrated; and will make splendid Christmas gifts from the elders who read this page.

17. HOME CARPENTRY, *by Edwin T. Hamilton,* contains over 100 different articles, ranging from book cases to bed-tables for the amateur craftsman, and includes 200 illustrations and plans.—$3.20 postpaid. . . . 18. OUR NAVY, *by Charles J. Finger,* gives an outline history of this important branch of our national defense (ages 10 to 14).—$2.15 postpaid. . . . 19. THE BOOK OF LIVING REPTILES, *by Raymond L. Ditmars,* famous curator of the New York Zoo, *and Helene Carter;* all about crocodiles, alligators, snakes, turtles, and lizards—where and how these strange creatures live.—$2.15 postpaid. . . . 20. DO YOU KNOW ABOUT FISHES?, *by Janet Smalley,* a new picture book in four colors and black-and-white, by the Philadelphia artist-author who has been so successful in making facts exciting for little children.—$1.40 postpaid. . . . 21. FAMOUS AMERICAN TRAINS AND THEIR STORIES, *by Roger Reynolds.* Dramatic stories of the best-known American trains—how they got their names, what rivers, mountains, deserts they cross.—$1.15 postpaid. . . . 22. MIGHTY ENGINEERING FEATS, *by Harriet Salt.* An authentic book for young people 14 and over. Vividly and authoritatively discusses 10 of the mightiest engineering feats which have gone into the making of our country. Photographs and line drawings.—$2.70 postpaid. . . . 23. MORE SONGS OF WILD BIRDS, *by Albert R. Brand.* Three double phonograph records made direct from nature are included with this volume, which is a guide to bird song for boys and girls of all ages.—$2.65 postpaid.

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truck is in motion, the circular, welded drum rotates slowly, thereby reducing the size of the contents by means of constant packing. To unload a truck, the rear circular wall of the drum is swung upward on hinges and the contents emptied in short time. Many foreign cities have also ordered a number of these trucks, among them Oslo, Norway, and Chemnitz and Potsdam, Germany.—*Holger Lundbergh.*

New Synthetic Adhesives

A NEW synthetic resin made from zinc chloride, urea, and formaldehyde (offered under the trade name "Lauxite"), has been developed as an adhesive for plywood. The new resin has a remarkably high speed of reaction at relatively low temperatures and forms a bond stronger than the wood itself. After heat treatment, the resin becomes permanently hard and has a high resistance to water and weather at ordinary temperatures. In comparison with phenolic resins used for the same purpose the output of the press units is practically trebled and manufacturing troubles are eliminated. The cost per joint with the new resin is about the same as with a good casein glue but the elimination of re-drying and the absence of stains as well as other advantages make the cost of the product with this resin much less than with a casein glue, and the quality is greatly superior.

Before heat treatment the new resin is soluble in water and can be applied in water solution to the wood. After heat treatment it becomes relatively insoluble and can only be dissolved by prolonged boiling. Other possible uses for resins of this kind, of which there are many variations, are in the field of plastic molding (because of the greater speed possible) as well as in sizing paper, textiles, straw, felt, and so on.—*D. H. K.*

Smooth Olive Oil Racketeers Foiled by Federal Food Men

IT was a good racket while it lasted—the "olive oil" racket with cheap tea-seed oil substituted for the more expensive olive oil. But a Federal chemist has at last found a way to identify the tea-seed oil, and the Food and Drug Administration has started legal action to confiscate thousands of gallons of the adulterated oil. The salad oil racketeers will now have to abandon tea-seed oil as a source of illegitimate profits just as in the past they have had to abandon cottonseed oil, peanut oil, sesame oil, sunflower-seed oil and others as adulterants of olive oil.

For some time the Food and Drug officials have been suspecting the substitution of tea-seed oil in "olive oil," but they could take no action against suspected stocks, because they could not go into court and prove the adulteration which the racketeer would deny. Tea-seed oil resembles olive oil closely in many respects, and answers to all of the recognized tests for olive oil. To make a case stick, they needed just one reliable test in which tea-seed oil would react in a way distinctly different from olive oil. The test just developed is that kind of a test.

Tea-seed oil is a commodity virtually unknown to most buyers of salad oils. It is pressed from the tea nut, or seed, produced by a plant closely related to that from which leaves for beverage tea are harvested. The major use of the oil, which is imported from the Orient, is in paint and textile industries. It may be used as a table oil when refined, and is not unwholesome. The Administration would have no ground for action against tea-seed oil sold as tea-seed oil. But it should be sold for what it is. Use of the tea-seed oil as an adulterant in olive oil is clearly a violation of the Food and Drugs Act.

"The operations of certain individuals in the salad oil business have been a source of concern to Federal officials in recent years," said W. G. Campbell, chief of the Food and Drug Administration recently. "They began with the adulteration of olive oil with cottonseed oil, peanut oil, sesame oil, sunflower-seed oil, and other fairly well known edible oils, for which identifying tests were developed. Competition among the racketeers led to the use of less and less of the costly ingredient—the olive oil—until oils were found in which there was no olive oil at all."

Pectin in Photography

PECTIN, familiar to American housewives as a valuable aid in jelly making, has been suggested and used in Germany to replace gum arabic in the process of photo-engraving. Gum arabic or gelatin becomes sensitive to light when treated with potassium chromate. Apparently pectin, which is derived from fruits and has the property of gelatinizing in solution, can be made similarly sensitive to light.—*D. H. K.*

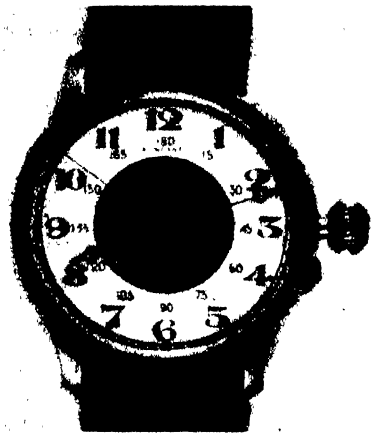
Synthetic Golf Ball Covers

CELLULOSE acetate compounded with an excessive amount of plasticizing agent has been suggested to replace gutta percha as the cover of golf balls. Since cellulose acetate is derived from wood, perhaps it is proper to suggest that golf balls may soon wear wooden overcoats.—*D. H. K.*

The Lindbergh Navigation Watch

ANOTHER phase of Col. Charles A. Lindbergh's inventive genius is revealed in his Longines-made navigation wrist watch

which permits direct reading of the Greenwich hour-angle, necessary in determining longitude. Describing his invention, Col. Lindbergh wrote, in part: "The dial is graduated both in time and in arc. . . . The chronometer is first set on Greenwich Civil Time, then correction is made for the equation of time taken at local noon. . . . Mrs.



New navigation wrist watch with the features described in the text

Lindbergh used a dial graduated in degrees for navigating our transcontinental flight. . . . She was able to save considerable time in working out lines of position."

The central dial is graduated into seconds of time and minutes of arc, 15 of the latter corresponding to 60 of the former, for the earth turns through one quarter of one degree every minute. The minute hand indicates minutes of time on the dial, and degrees of angle of the earth's rotation on the bezel, for the earth turns 15 degrees an hour. The hour hand not only indicates the passage of time, but also shows the number of degrees through which the earth rotates, marking 180 degrees in a 12-hour period.

The dial marking seconds of time may be rotated to synchronize this watch with radio time signals, and the rotatable bezel compensates for the equation of time without the need for mathematical computations at each reading.

Land Tilts; Harbors Deepen

CANADA and the United States may have reciprocal trade agreements but the United States is benefiting at the expense of Canada in another matter over which man-made laws have no control. Harbors on the American side of the Great Lakes are getting deeper and those in Canada are becoming shallower.

The reason, as revealed recently by Capt. H. V. Canan, U. S. Corps of Engineers, is that the region about the Great Lakes is tilting about a "hinge line" which roughly is in the direction of 20 degrees west of north.

This tilt, says Capt. Canan in *The Military Engineer*, is generally improving conditions in harbors on the American side of the Great Lakes. He adds:

"This action is of material rather than merely scientific interest and amounts to as much as 0.3 feet in some harbors. Considering vast harbor areas which are maintained to prescribed depths, a large saving in maintenance dredging costs will result when the effect of tilt on American harbors is given proper consideration.

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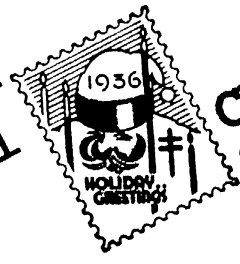
BUY 

CHRISTMAS SEALS

The National, State and Local Tuberculosis Associations of the United States

"This uplift also affects the flow and the flow equations in the connecting rivers of the Great Lakes, and in computing flows for these rivers over extended periods its effects are clearly recognizable. Tilt has also been a factor in decreasing the available depths over the sills of the locks at Sault Ste. Marie, Michigan.

"Much of the evidence presented of decreasing lake levels is in reality the effect of tilt. Reports indicate that in about 1860, North Bay, Wisconsin, was an important harbor for schooner navigation, as many as 35 boats tying up there at one time. Adjoining a rock ledge, old ring bolts used for mooring these boats can still be found. Correcting the present charts for the stage of 1860, only about 3 feet of water would have been available. This loss of depth can only be attributed to earth tilt."

Describing what effect the observed land tilting will have on the future of the Great Lakes, Capt. Canan says:

"There has been much sensational speculation as to the geological future of the Great Lakes. Rather than the danger of the lakes draining down the St. Lawrence through failure of the outlet plugs, the more apparent danger, if tilt persists, is the draining of the Great Lakes above Niagara down the Mississippi system. While speculation of this sort may be mentally stimulating, any danger is so remote, and the engineering steps necessary for prevention are so relatively simple, that there is little danger of losing the vast investment made by the United States and Canada on the Great Lakes."

Generally accepted explanation for the land tilt on a line passing through the Great Lakes is that the land to the north, in Canada, is still rising from the enormous squeezing which it received during the last Ice Age.—*Science Service.*

Expansion Joint Bumps

MANY concrete highways are notoriously bumpy because of extruded joints. Such joints not only are undesirable but also are a constant menace to the safety of cars since they tend to throw the car out of control.

A new material for expansion joints, which is rapidly being adopted by concrete highway designers, is made of tough cane

Solid asphalt expansion joint filler mushroomed out; result—a bump

New expansion joint filler after use. No mushrooming; hence, no bump

fibers. Called "Flexcell," this material is impregnated with a special asphaltic compound which gives it permanency and additional resistance to water. Its chief advantage lies in its ability to withstand the compression of expanding concrete while at the same time it maintains a close bond with the concrete on both sides. It expands as the concrete contracts, thus keeping a tight joint under all conditions.

The long, interwoven, cane fibers provide necessary rigidity for easy and quick installation. The compound is not affected by extreme temperatures, so that it may conveniently be handled under all working conditions. It is light in weight, easily cut, and may be stored on the job since it holds its shape indefinitely.

ALBINO

LACK of pigmentation, occurring relatively often in most animals, is seldom found among bats. The Field Museum of Natural History is, therefore, fortunate in having an exceedingly rare specimen, an albino bat of the species *Myotis lucifugus*, which was caught in Wisconsin.

PLENTY PULPWOOD

WESTERN Washington and Oregon contain enough potential pulpwood to supply all the pulp mills of the United States for 50 years, according to Thornton T. Munger, director of Pacific Northwest Forest Experiment Station. With intensive forest management, according to Munger, the forest acreage in this area can grow annually sufficient pulpwood to supply the present needs of the nation's pulp and paper industry indefinitely.

Munger called attention to the fact that the Pacific northwest, particularly in the coast region, is a prolific producer of important pulpwood species, including spruce, hemlock, and white fir, and that investigation has revealed instances of a growth of better than two cords per acre per year.

As a practical matter, according to Munger, the pulp and paper industry cannot depend upon the exclusive use of this pulp timber, since the same species are in demand for lumber.

"In the distant future," stated Munger, "when the non-growing old stands are out

(*Please turn to page* 362)

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THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

MERE men occasionally qualify as stenographers, nurses, ladies' tailors (said to be much better than women at that trade), and even milliners, but women telescope makers are still more scarce. Here, however, are accounts of two women who have qualified.

Mrs. Bessie M. Brownlow, 288 North Eighth St., Marshfield, Oregon, writes: "In perfecting the instrument shown in Figure 1, the Scientific American's book 'Amateur Telescope Making' was consulted freely and frequently. For the mirror a disk of commercial plate glass, 8" in diameter and 1½" thick, was used. Grinding was done outdoors with the tool mounted on a deeply set post, and the time consumed was 8 hours, 5 minutes.

"Applying the Foucault test, after a short period of polishing with the conventional pitch lap, revealed that I had developed a hyperboloidal figure. I could, of course, have reversed my disk and gone through the process of re-grinding, but instead I chose to rub out my error with rouge, and from that point forward I worked 'up-hill'. I poured a new lap and proceeded, but shall not attempt to explain at length the altering of facets and modification of strokes which were necessary before I was able to detect the shadows which told me that at last I had achieved a satisfactory parabolic surface. Final tests were made on Saturn and Vega with the mirror temporarily mounted in the tube, and even in its unfinished state the image was sharp and well defined."

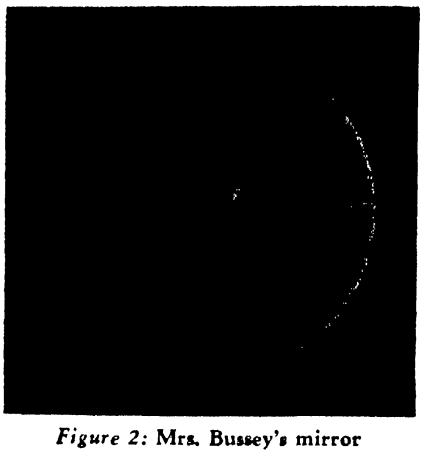

Figure 2: **Mrs. Bussey's mirror**

Mrs. Brownlow states that two sons assisted to the extent of devising the cell block and making the mounting. She also gives credit to Mr. H. B. Donahay, who had previously made two Newtonians, for his counsel.

WE had always heard that H. E. Bussey of Atlanta was a wizard telescope maker who followed the hobby years before there was any "A. T. M.", but now it appears that the same household holds a wizardess as well. Figure 2 is a focogram of a mirror made by Mrs. Bussey, and Figure 3 is the ronchigram. The mere man in the case writes: "My wife had listened and looked in silence at 25 years of my efforts to make a good mirror. She said, some time ago, that if the materials were provided, she would prove that a woman could beat a man at it. I didn't like the way she said it, the man of course being myself, hence materials were immediately produced. I was not permitted to touch the mirror, except that in final figuring a 'pile of rocks' showed up in the central inch and I was permitted to use a small polisher to remove them, and of course I did this with careful supervision and copious advice from Mrs. Bussey. The mirror is excellent. A hair got across the film and looks like a scratch but there are none, and the central spot is the photographer's fault. I was the photographer."

Figure 1: **Mrs. Brownlow and scope**

And Mrs. Bussey writes: "I realize that it would have been utterly impossible for me to have produced anything like as good a mirror if it had not been for the guidance I received,"—a graceful recognition, though we hate to publish it, preferring to believe that the ladies can do it without *any* help. In fact, we know one who could but, confound it, she won't.

SOMETIMES we wonder just how important it is *in the average case* to test a mirror across different diameters. Once the test rack is adjusted so that the reflected cone strikes the most convenient place to do the testing, it is always a temptation to place the mirror on the rack with the same diameter up (usually determined by some landmark or blemish on the disk). This may have the unhappy result that some kind of flexure is accidentally masked, but it is human to take a chance, on the presumption that the figure itself is a surface of revolution and the flexure, if any, will sort of "unlax" if talked to in nice purring language—which it won't. From the depths of our stock drawer we fish up an old photograph, Figure 4, sent in 1928 by Mr. Henry H. Mason of Florida, since deceased. It is self-explanatory—a belt hung from a pulley, with a little crank for rotating the mirror. Before his death Mr. Mason was building a large (20"?) Cassegrainian and had a large Ritchey-type grinding machine. These remain at East Pensacola, Florida, a fact which may interest some southern amateur on the look-out for something that ought to be put into use.

AS these notes are being written, on October 15, it is at last possible to say something a little less indefinite about that "new book" we have been promising for a year or so. At last we were able to get in all the many contributions and work them up into a single pile and this, when sent to the printer on September 18, made a manuscript of 860 typewritten pages. This is now being set in type and every day or two brings us a dozen more galley proofs to be corrected and sent to the authors to be again read and corrected. As there are just 47 chapters, some of them as long as many books themselves, all this is quite a "job of work" (try it and see).

When will the book be ready? We still don't know, and if you are impatient please don't shoot the editor—he is doing his best. We have set our hopes on being "out of the trenches by Christmas." Piloting a complex book through preparation is worse than rearing quintuplets, and this *is* a complex book—in addition to which there will be a lot of it—pretty close to the size of "A.T.M." and on the upper side at that.

Here are some of the chapter subjects: Everest on his close mirror technic. (He was asked to set down "everything he knew," and this item should run to 30 pages of compact dope, all practical and definite. If you've seen some Everest mirrors you'll know what that means.) Chapter on use of sub-diameter tools. One on metal tools. Another on metal mirrors. Warner on detecting astigmatised mirrors—a subtle game, this. One on the Zernike test, by Dr. Burch, English physicist. Huh—what's that test? It's a new one and mighty interesting. Selby on flat making—full, detailed dope. Clark on small lenses and eye-

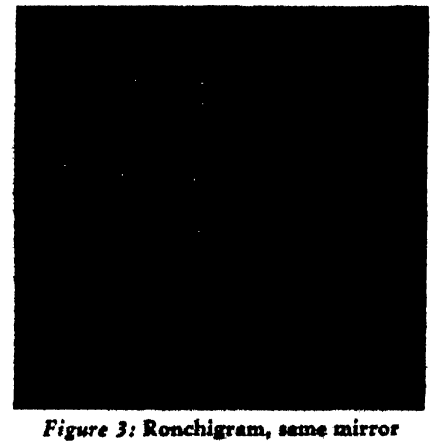

Figure 3: **Ronchigram, same mirror**

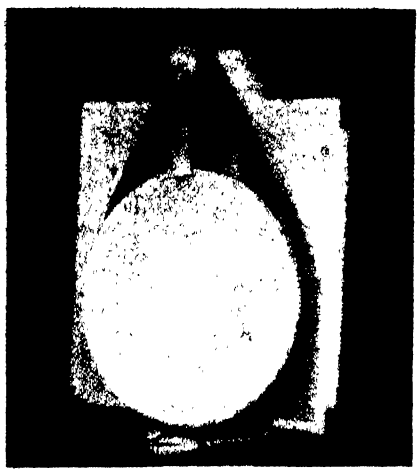

Figure 4: Mr. Mason's support

piece making—all practical and very detailed. Taylor on the metal parts for a refractor, likewise practical. Kirkham on rifle sights. Haviland on the refractor—the longest chapter in the book, about 40 pages uniform with those of "A.T.M." Chapter on making setting-circles. H. A. Lower on design of clock drives, with auxiliary chapters on spring drives. A long, very detailed section on the Springfield mounting, by Porter and Ferson. Porter has revised his famous mounting and made it neater, heavier, and more rugged. He tells how to make the patterns, Ferson tells how to cast them, and Porter again tells how to machine and finish the whole mounting. Detailed dimensioned drawings—the whole Springfield down cold.

To continue: Making a 19" reflector. Schmidt, telescope. Camera obscura, by Dall—this is an interesting item. How to make a Synchronome clock, by Souther. Micrometers. Chronograph. How to aluminize mirrors, by Strong. Scanlon on observatory design. Meteor timer, by Halbach. This the main drift in Part I, but much has been skipped.

Part II, a much shorter part, more on the use than the making of things: Halbach on organized observing. Millman on meteor photography. Von Arx on celestial photography . . . and so on for nine more chapters. We hope to publish next month a more detailed announcement of all chapters in the book, and later the precise data.

What is the name of the book? A year ago it was to be called a "Supplement" to "A.T.M." Then it grew too big for that and we dubbed it "A.T.M., Vol. II." Later we became afraid the uninitiated beginner would think he had to get this as well as "A.T.M.", all at one time, and would pass out, so we renamed it "Amateur Telescope Making—Advanced," and that's final; we call it "A.T.M.A." Hence this book isn't a part of "A.T.M." but a wholly separate book—though it is being printed uniform with "A.T.M." in every way.

WHEN Prof. Russell's article on the red reflection nebula near Antares came in, and mentioned a Schmidt camera used by the Yerkes staff at McDonald Observatory in Texas, we suddenly recalled that C. H. Nicholson, one of the Amateur Telescope Makers of Chicago, made the optical elements of that camera. Urgent requests for data and a photograph brought the former from Mr. Nicholson and the latter, Figure 7, from Dr. Struve (through

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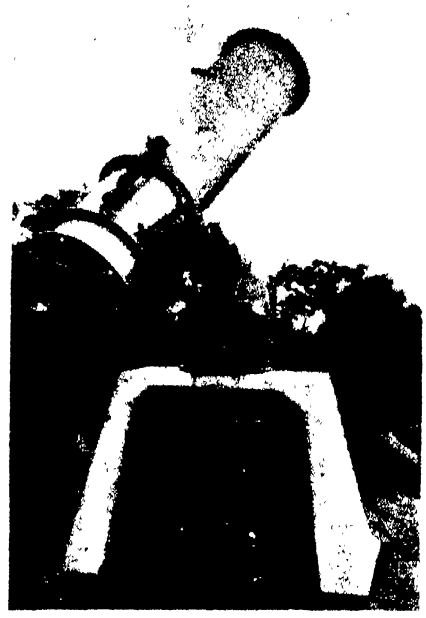

Figure 5: **McAdam's solid comfort**

the kind assistance of A.H.C. of Chicago, who can produce, at instant's notice, anything anybody wants). Mr. Nicholson writes:

"Dr. Otto Struve, Director of the Yerkes Observatory of the University of Chicago, who is also in charge of the construction and operation of the new McDonald Observatory, indicated to the Chicago amateurs his inability to produce from professional makers two Schmidt cameras to be used in connection with the quartz spectrograph and the 82" telescope of the Texas Observatory.

"As a good deal of original research hinged upon the procuring of these instruments, Dr. Struve suggested that the Chicago Amateur Astronomical Association attempt the task as one means of aiding in the advance of astronomical knowledge. Mr. William Callum and Dr. A. H. Carpenter, the guiding spirits of the Club, requested me to build the first camera.

"The specifications for this camera were that the mirror was to be of Pyrex, 122 mm clear aperture and 180 mm focal length, with a correcting plate of UV glass at center of curvature and of 92 mm clear aperture.

"Although the mirror gave me no real trouble, I found the correcting plate very difficult to figure, for the reason that it was necessary to do all the correcting by fine grinding with small tools and then repolishing to examine the figure. This involved a great deal of time, as it is very easy to make large errors when figuring by grinding in this manner. Testing was done by pinhole at focus of the Schmidt camera and the knife-edge at focus of a 6" telescope. All curvature was placed on the front surface, necessitating a convex curve at the center, changing to an equal concave curve at the edge of the plate.

"Upon completion it was tested by Dr. Morgan of the Yerkes Observatory Staff and found to yield star images as small as he had ever seen; their size being limited by the grain structure of the photographic plate and were therefore less than the resolving power of the optical combination."

Figure 6: **McAdam's support system**

Dr. Struve points out that the photograph (Figure 7) shows the camera "in highly foreshortened form, as seen from the top. The correcting plate is in the plane of the top surface of the box, and we are looking through this correcting plate into the camera. A part of the spherical mirror shows as a white segment upon which is projected the device for holding the plate." A.H.C. states that the mounting (that is, for the Schmidt itself) was designed by Dr. G. W. Moffitt of Yerkes and made by Gaertner.

Schmidt enthusiasts will find, in addition to the matter in "A. T.M.A.," by Russell, Wright, and Lower, an excellent article on the Schmidt, by Prof. C. H. Smiley of Brown, in the October, 1936, *Popular Astronomy*.

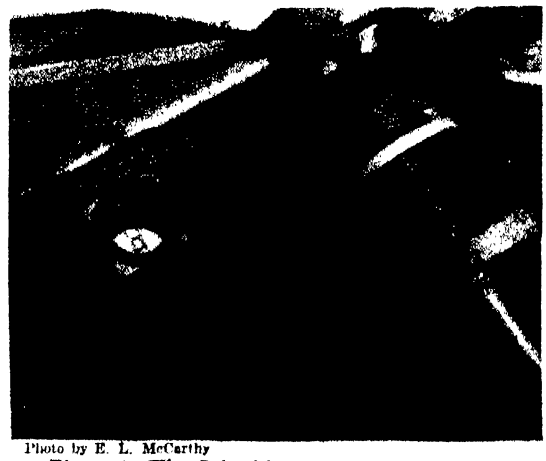

Photo by E. L. McCarthy

Figure 7: **The Schmidt camera temporarily attached to the Porter mounting on Yerkes' roof**

FIGURES 5, 6, and 8 show a telescope made by J. V. McAdam, a mechanical engineer, Hastings-on-Hudson, N. Y. It is a 12½" Newt-Cass combination of Springfield type. The first feature is the solid concrete bench pedestal built for solid comfort—not having to straddle a pier. We long-legged fellows have a hard time folding

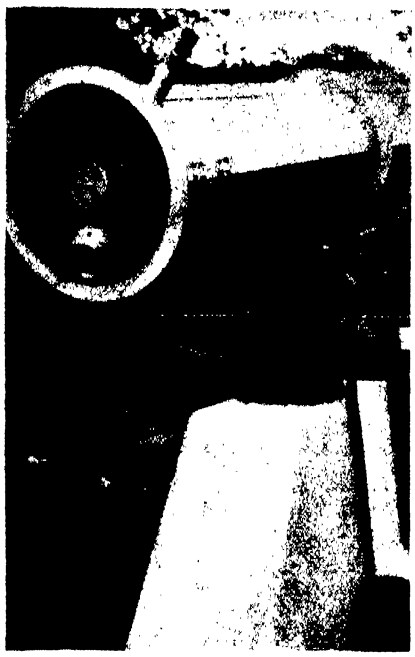

Figure 8: McAdam's two supports

up our hind legs in just such places, and McAdam's solution of the jack-knife leg difficulty is fine. He writes:

"Wires for the motor drive and light inside the mounting come up through the concrete. The P.A. has a hole clear through it for locating it on the celestial pole; a 1¼" tube with cross-wires fits into the eyepiece tube, and there is a peek-hole in the south end of the P.A. I find this ideal for adjusting: just turn the cross-wire tube till it is in the right hour for Polaris, move the mounting till Polaris is at the cross-wires, and clamp down.

"Dec. axis is a 2½" steel tube (2" internal) pressed into P.A., with a 6", 10-P. gear keyed to outer end, and the casting carrying the tube rotates on this steel tubing, carried around by a worm running on the stationary worm gear. The P.A. has an 8", 10-P. worm gear with hand wheels on either end of the worm shaft, the motor clutch being operated by the left thumb.

"Figure 6 shows the cell and flotation system with part of the first prism adjustment. The prism is carried on the inner end of a 2¼" tube mounted on the six-leg spider extending into the barrel. For a change to the Cass the prism assembly is removed. Castings of the cell can be had at cost, in duralumin.

"The final photograph shows the combination support for the Cass secondary and Newt prism.

"Both mirrors are Pyrex. A tin can cover over both ends of the barrel puts the scope up for the night, whereupon everything is water-tight without further shelter. Once I had to chop it out of the ice but it functioned, even then."

THE question often comes up, "can anyone successfully make his first mirror on a machine, with no previous hand experience to learn the 'feel' of the work?" We have generally recommended making at least one mirror by hand but advice of that kind seldom is taken willingly by a tyro who has the machine complex. Can it be done? Another question: Does anyone silver mirrors any more, or have aluminized mirrors already made a clean sweep?

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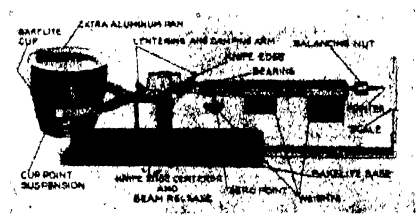

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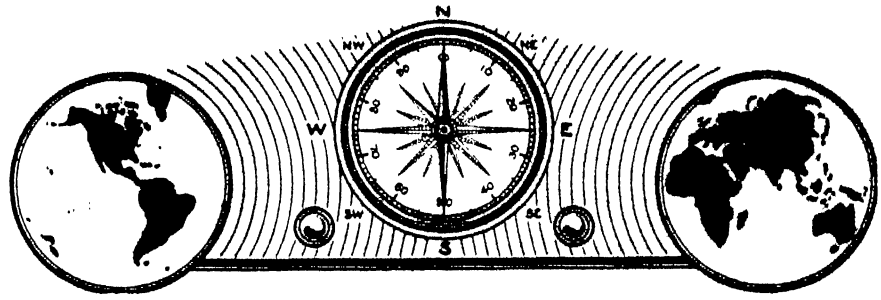


WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN
Editor, *All-Wave Radio*

Dx Season is Here

THE DX season is now in full swing. Practically all bands are free from atmospherics, and stations normally unreceivable during the summer months are now coming through in fine shape. The 49-meter band is now worth listening to, and the 10-meter amateur band, which was dead during the hot months, has come to life.

A batch of new stations has arrived on the scene and they are worth listening for. The more important ones are:

Call	*Frequency*	*Location*
VQG	19620	Nairobi, Africa
IBC	17620	San Paolo, Italy
ITK	16385	Somaliland, Africa
——	15230	Prague, Czechoslovakia
IBC	14410	San Paolo, Italy
IBC	11955	San Paolo, Italy
——	11760	Prague, Czechoslovakia
COCX	11450	Havana, Cuba
HIN	11280	Ciudad Trujillo, R. D.
ITK	10480	Somaliland, Africa
PSJ	9660	Rio de Janeiro, Brazil
RAN	9600	Moscow, U. S. S. R.
VPD2	9540	Suva, Fiji Islands
HS8PJ	9350	Bangkok, Siam
IDU	7890	Eritrea, Africa
HIN	6243	Ciudad Trujillo, R. D.
——	6115	Prague, Czechoslovakia
GSA	6050	Daventry, England

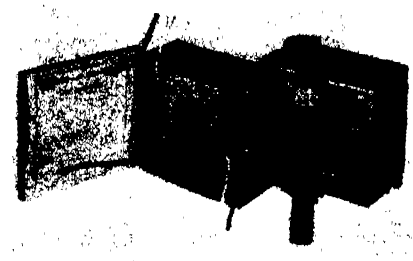
The frequencies given in the above list are in kilocycles. Divide by 1000 to read in megacycles; thus, VQG operates on a frequency of 19.62 megacycles.

Filter for Oil Burners

TO eliminate the radio interference which prevents intelligible reception of broadcast and short-wave programs during the ignition period of an electrically ignited oil burner, a special "Filterette" has been developed.

This unit, installed between the primary of the ignition transformer and the remainder of the oil burner wiring keeps ignition interference off the power system without in any way affecting the operation of the burner. Contained in a standard cut-out cabinet 6 by 6 by 3 inches, the Filterette conforms to the rigid electric wiring regulations surrounding oil burner installation. It comprises a series of specially designed high-frequency inductances in both sides of the power-supply line to the oil burner ignition system and has associated with these inductances, in the correct relation to provide maximum interference attenuation, capacitive sections constructed so as to be safe for continuous AC operation in circuits containing high transient voltages.

An important feature contributing to ease of installation is the provision of detachable mounting brackets, as shown in the accompanying illustration, by means of which the Filterette may readily be attached to one of the pipe standards supporting the oil burner. The brackets are so constructed that the Filterette may be mounted either vertically or horizontally, whichever is more convenient for the electrician making the installation.



Courtesy Tobe Deutschmann Corp.
Radio filter for oil burners

Signal Absorption

IS there a theoretical limit to the number of radio receivers which can receive a broadcast from a particular station, asks a radio fan of General Electric's engineers. By rough calculation, engineers have estimated that within a 100-mile area of WGY in Schenectady, it would be eight hundred billion. That number of radio receiving sets all working at once in the area would probably absorb the energy output of the station, but as there are approximately only a billion people in the world there seems no danger of this ever happening.

New FCC Short-Wave Regulations

EXPLAINING the reason for the change in announcements over stations W2XAD and W2XAF, Schenectady, N. Y., B. W. Bullock, assistant general manager of broadcasting for General Electric, recently explained the effect of the new Federal Communications Commission regulations regarding short-wave broadcasting in this country.

Under the new regulations, he said, stations that have been "experimental relay broadcast stations" are now known as "international broadcast stations," the new name being significant of the service rendered. The rules also provide that no United States short-wave station may operate with less than 5000 watts power. A reduction in the

transmitter frequency tolerance from 0.03 to 0.01 percent, he said, will reduce international interference. The aim of the FCC, he said, is to place emphasis on the foreign service of United States short-wave stations and to encourage programs of international scope.

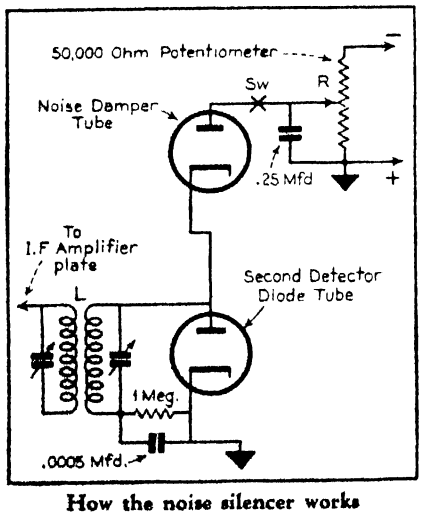
New Noise Silencer

THE development of a system for silencing man-made noise in radio receivers was described in these columns some time ago. The operation of the system is based on the knowledge that such noise impulses as those radiated by the ignition system of an automobile, by a vacuum cleaner, dial telephone, and so on, are of such short duration that if the radio receiver is made inoperative during the time the impulses are present, the noise may be silenced without creating an apparent break in the continuity of the received radio program.

This noise-silencing system has proved its practicality in innumerable instances, but its use in some cases has affected the operation of the receiver with which it was employed.

A new system has been developed which, aside from its simplicity, has the advantage of wide applicability. It can be used effectively in conjunction with any type of superheterodyne receiver without apparently disturbing receiver stability and without requiring complex alterations in the receiver circuit. Besides, the new system requires but one tube, and under certain conditions no additional tube at all.

The former system of noise silencing employed a fast-acting automatic volume control circuit which influenced the gain or amplification of a special tube inserted in the intermediate-frequency amplifier. The new system operates directly from the diode second detector in the receiver and dampens or short-circuits this stage on the appearance of noise impulses. The additional 6H6 diode tube attached to the second detector actually functions as a fast-acting electronic switch.



How the noise silencer works

The circuit of the new noise silencer is shown in the drawing. The lower tube represents the diode second detector of the receiver, which is fed by the intermediate-frequency transformer L. The upper tube, which is a simple diode similar to the one used in the receiver, is the noise damper. A voltage balance is maintained between these two tubes so that under conditions of no noise the damper tube remains inoperative. Upon the appearance of a noise impulse in this circuit, however, the voltage balance is affected, the damper tube draws current and in so doing effectively short circuits the second detector diode tube. At the termination of the noise impulse, the voltage balance is re-established, the damper tube becomes inoperative and the second detector again functions normally.

The proper voltage balance is established by the manually controlled potentiometer, R. This is adjusted to the normal signal-voltage level as maintained by the automatic volume control in the receiver. Therefore, any voltage greater than the signal voltage will dampen or short circuit the second detector tube.

The switch, SW, is used to discontinue the action of the noise damper tube when receiving exceptionally strong signals under which condition the noise damping action is not required.

"Q" Signals

NO doubt you have heard amateurs repeat such letter groups as QRA, QRZ, QSL, and so on, and wondered just what they meant. These are the International "Q" signals, known to radio operators throughout the world, but possibly not so well known to all short-wave listeners.

Each "Q" signal may take the form of a question or of an answer. Thus, QRA? means "What is the name of your station?", or when used by the amateur simply, "What is your location?" or "What is your address?". The answer might be: "QRA—220 Circle Road, Eastchester, N. Y."

Here are the "Q" signals most commonly used by amateurs, the interpretation in each case being given as a statement rather than a question:

QRA—My location is ———.
QRK—I am receiving you well.
QRM—You are being interfered with.
QRN—There is static interference.
QRT—Stop sending.
QRX—Stand by.
QSA—The strength of your signal is ———.
QSL—Please acknowledge.
QSO—I am (was) in communication with ———; I can communicate with ———.
QSY—Change transmission to frequency of———.

These interpretations are at slight variance with the originals, since the amateur follows a slightly different form of communication practice. Thus, QSO actually means, "I can communicate with ———," but the amateur gives it a broader meaning. He will say, "I had a 100 percent QSO with so-and-so," meaning that he talked or communicated with such-and-such an amateur and that the entire conversation was intelligible. Likewise, QRM is used by the amateur to denote interference. He will say, "There is plenty of QRM," meaning there is plenty of interference, but not necessarily that the station with which he is communicating is being interfered with —though that is usually the case.

The amateur has his own abbreviated language as well—a hangover from the days when all communication was done by telegraph key. Thus, FB means "fine business"; HI denotes laughter; K means "go ahead" or "start transmitting"; R means "all right" or "okay"; OM means "old man," OW "old woman," and YL "young lady." An XYL is an "ex-young lady" or the wife. The number 73 means "best regards," and 88 means "love and kisses."

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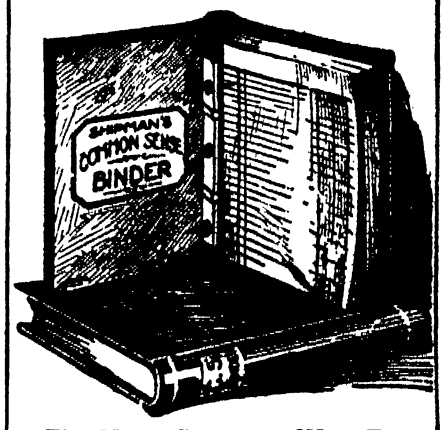

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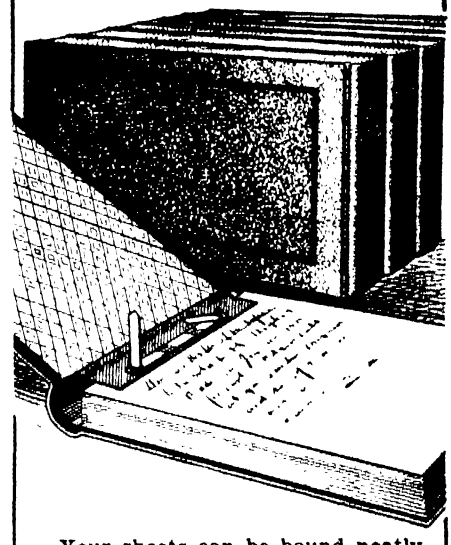
Bulletins



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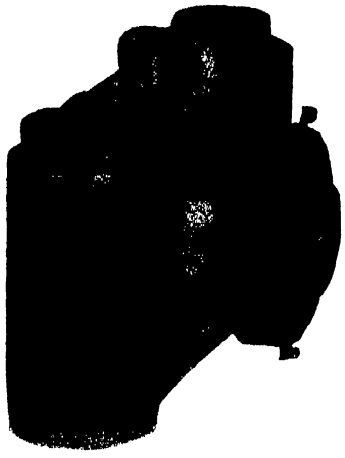

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Pictures By Candle Light

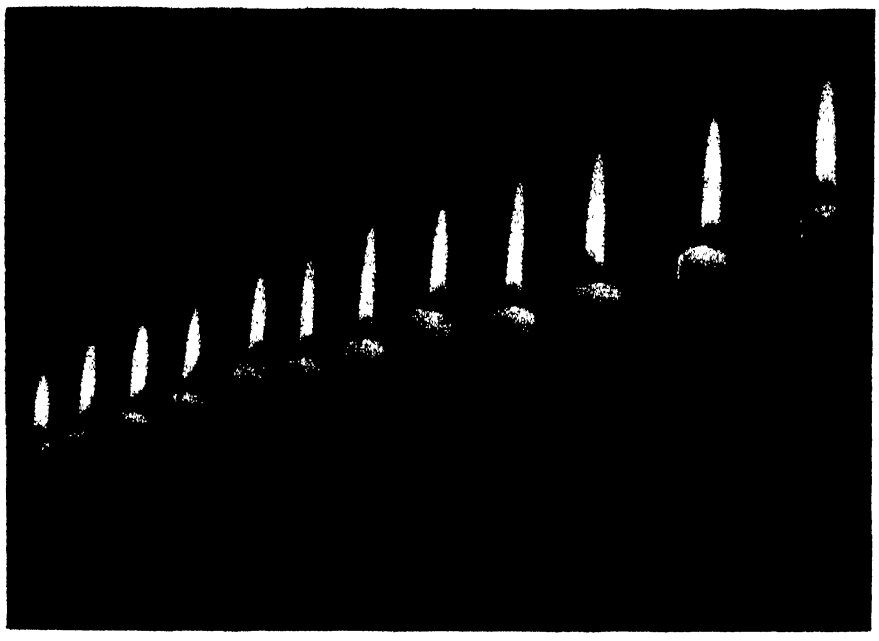
CONSIDER the candle and the varieties of shapes, colors, lengths and thicknesses in which it is available. From the humble penny candle for the tiny birthday cake it ranges all the way up to elaborately designed pieces fit to grace a king's table. Now it is simply utilitarian, as in the case of the thick so-called plumber's candle or the cheap candles that furnish light when the fuse blows out; now its tiny flame on the anniversary cake goes whisking away before the determined blowing of the chief guest. In one of its most delightful roles, it lends atmosphere and romance to the dinner table.

Candles have often been used in photography to illuminate a face and in this phase they have been looked upon as an aid in the making of trick pictures, but their usefulness as both illuminant and subject has not been exploited to the full extent of their varied possibilities. Two such opportunities are here illustrated. In "Design for a Bookplate" the plumber's type of candle was used and the glass bottom support intentionally employed to carry out the idea of a simple home workshop. Incidentally, the type of candle base or holder that is used may often make or spoil a picture. Poverty may be depicted by using a chipped saucer and a candle nearing almost the end of its life span; elegance will be suggested by the use of a tall tapered candle in a decorative candlestick. In this connection, the dictates of style have it that a short candlestick should support a tall candle, a tall candlestick a short candle.

"Lighting in the New Year" is a suggestion that might be used for a New Year's greeting card, the word "Greetings" being printed or written in letters of graduated sizes in the upper triangular space, while the number of the year is placed in the triangular space in the right-hand corner at the bottom. It is obvious, of course, that the newly lighted 12 burning candles represent the 12 months comprising the new year about to start.

Exposures may be quite short if it is desired to record only the flame of the candle but when, as will be the case in most instances, you will want to record at least some of the candle itself, a considerably longer exposure will be needed and some reflecting material employed, as in the case of the boards in "Design for a Bookplate." The New Year greeting designed was photographed at such an angle as to produce the result seen, the larger candle having been, of course, nearest the lens. However, reversal of the negative in printing was found to give a better arrangement. The candles are standing on the edge of a length of board and the background, being dark, does not show, leaving the space at top and bottom clear for the lettering. In order to get over-all sharpness despite the near viewpoint of the camera lens, the diaphragm was stopped down to F:32, but an exposure of 10 seconds was found to be ample.

"Design for a Bookplate"



"Lighting in the New Year"

Photography by candle light lends itself to varied inventions. By giving the subject a little study, supplemented by considerable experimentation, some quite original ideas may be evolved which may not, at first thought, seem possible. One inspired photographer once had the happy thought of photographing two thick candles quite close up, only one of which was burning, the other, having been blown out, sending up curls of smoke. The candles were, of course, illuminated by another light, doubtless artificial, and this leads to the suggestion that some fine things may be done by employing artificial light to get a diffused, subdued, general illumination for a candle set-up.

Paper Towels

IN the cause of cleanliness, let us suggest the use of paper towels in the darkroom. A rack to hold the regulation roll may be had for about a quarter and the rolls of towels cost about a dime a piece. Attached in a convenient place they will prove a comfort on many an occasion, especially, of course, during a busy period of darkroom activity. The rack holds the towel roll firmly enough to permit tearing off one of the perforated sheets without having to use both hands, yet is sufficiently loose to allow rolling.

Cooling

DURING the summer this department offered, in the nursery ice box, a method of keeping solutions within reasonable working temperature all the time. With winter upon us, we now offer the window box for the same purpose. The solution may be much lower in temperature than is desirable but, as has been remarked here on another occasion, it is much easier to raise temperature than to lower it. Our experience has been that immersion of the container in hot water will raise the temperature about 10 degrees in a minute or two.

Annuals Time

THIS is the season of the photographic annual. Full page reproductions enclosed in ring binders assail us from all sides. All of them have something worth while in them, though some are marked by a higher general excellence than others. Glance through them all at your dealer's and buy one or more—if you can afford what it takes. In the main, they contain the work of the best photographers of the day and you can do worse than ape some of the better ones. Of course, we do not really mean aping, for every photographic worker should try to infuse something of his own individuality into every picture he turns out, but a close study of the work of the better photographers and an effort to take from their work certain ideas to help develop his own should be attempted by every serious amateur. Another service of the photographic annuals is the inspiration and incentive to better work that permeate their contents.

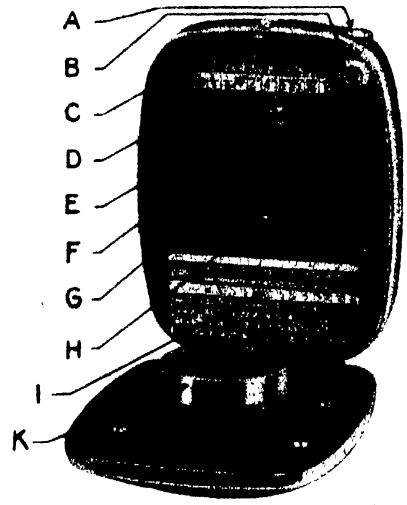
Spotting Glossy Prints

THE idea of "doping" a glossy print in order to make pencil marks "take" has been tested by this department and found to measure up almost perfectly, working better, however, on chloride than bromide papers. Spotting glossy prints has always been the bugaboo of the hobbyist, who has often given up the attempt as a bad job and turned the print out on a semi-matte paper instead, on which spotting is very much easier. But there are times when a glossy print is the only thing that will do, as in the case of pictures submitted for reproduction. Dropping some retouching dope on the area to be spotted and then rubbing it well down makes a good working ground for the pencil and may furnish the solution to some of your spotting problems.

For Mailing Pictures

HERE'S a penny saver that may be useful to those readers who mail a sufficient number of photographs to make it worth while. Instead of purchasing the regular "photomailers," the cost of which mounts up considerably when many are used, such as would be the case with those who submit pictures to magazines and newspapers or the salons, buy ordinary clasp envelopes, which are quite cheap when purchased in quantities of 50 or 100, and a dozen large sized

VEST POCKET
ELECTRO BEWI
EXPOSURE METER



(Electro Bewi Exposure Meter Opened)

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B Adjustment of sensitivity
C Stops (Diaphragms)
D Exposure times.
E Light value figures
F Emulsion speed
G Scale of light values
H Focusing screen of the optical meter.
I Depth of focus scale
K Hood with photo cell

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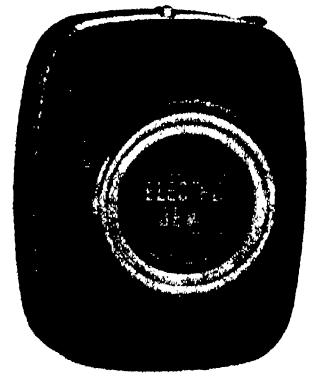

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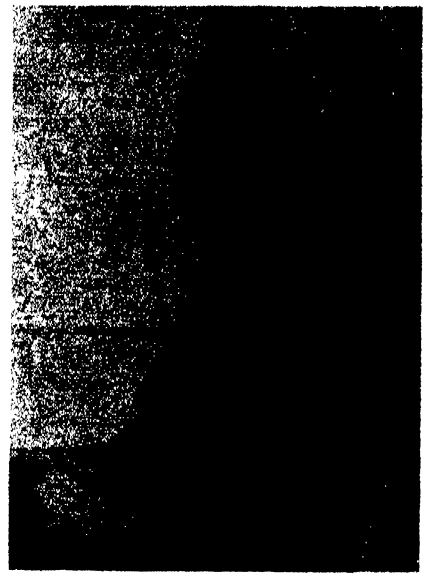
Photoflash Work

A SPEED flash exposure scale devised by the distributors of the Kalart outfits for synchronizing flash bulb and shutter will be found useful to those interested in this attractive phase of photography. The scale calls for the use of one flash bulb in connection with Verichrome type film, exposures on supersensitive panchromatic or similar extra fast film being made at one stop smaller than that indicated in the scale. The scale follows:

Distance lamp to subject	Lens stop to use with: Standard No. 20 (25 c. list) 1/100 or 1/200th sec.	No. 10 (15 c. list) 100th sec.
6 feet	F:16	F:11
10 feet	11	8
15 feet	8	6.3
20 feet	6.3	4.5
25 feet	4.5	3.5

Concerning the speed of the flash bulb, generally understood to be about 1/50th



With one Photoflash bulb

second, Kalart has this to say: "A standard size flash bulb has a total effective duration of about 1/50th second. However, during this short period of time the light emission is not constant. Upon ignition, the light gains rapidly in intensity, remains at maximum intensity for only 1/200th second, then dies out gradually."

Answering the query of how it is possible to expose a film properly at 1/100th second, it is further added that "actually about 70 to 80 percent of the entire light output is generated in one quarter of the entire light duration" and that this high intensity, usually referred to as the "peak," lasts, as above indicated, about 1/200th second.

Referring to the "hard, flat lighting usually associated with speed flash photography," the distributors say that "it is due to the flash bulb being fired directly from the battery case attached to the camera" and that it can be overcome "by simply using an ordinary lighting fixture which is not permanently wired to the house lighting system" and plugging the electric cord of that lamp into the socket of the battery case, thus offering "a flexible means of

Build a Photographic Library

Leica Manual, *by Willard D. Morgan and Henry M. Lester.* A beautiful book of over 500 pages dealing with all phases of miniature photography. It covers such subjects as panoramas, photomicrography, dental, stage, and aerial photography, photomurals, infra-red, and many others. $4.00.

Practical Amateur Photography, *by William S. Davis.* Deals with the whole subject from the origin and growth of photography to the latest types and uses of cameras. 264 pages, illustrated. $2.40.

Photographic Enlarging, *by Franklin I. Jordan.* A complete treatise on enlarging, discussing not only the necessary equipment but all of the dark-room processing dodges which may be employed, combination printing, mounting, and lantern slides It is written in a light yet thorough-going manner. $3.70.

Free-Lance Journalism With a Camera, *by Rufus H. Mallinson.* Many serious amateur photographers would like to know how to make money with their cameras; here is a complete guide to that work. It tells not only how to make salable pictures but also how to market them. $1.65.

The Fundamentals of Photography, *by C. E. K. Mees.* Not only tells how to take and finish pictures but gives a solid foundation of the principles of photography. $1.10.

Portrait Lighting, *by Frank R. Fraprie.* Takes up the rapid development in the last few years of artificial lighting for indoor photography. $2.15.

Modern Development, *by F. R. Fraprie.* Describes all methods of development, stressing particularly modern factorial and thermo methods. All formulas are given. $1.10.

Camera Lenses, *by Arthur W. Lockett.* Explains simply and clearly, yet with scientific accuracy, all the underlying principles of lenses. 85c.

Infra-Red Photography, *by S. O. Rawlings.* A treatise on the use of photographic plates and films sensitive to infra-red. Exposure and processing are fully covered and many formulas are given for sensitizing. $1.65.

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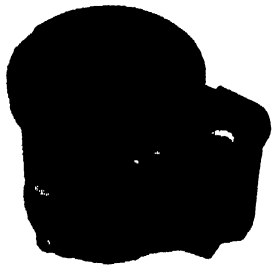

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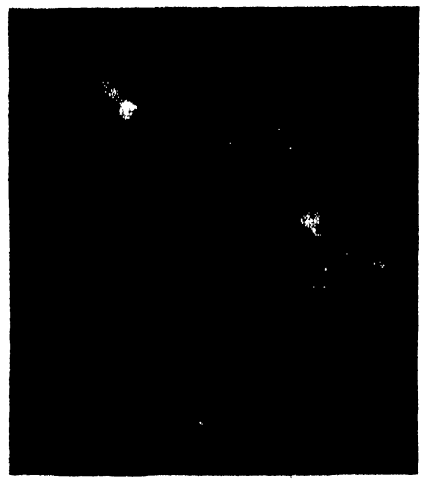
changing the location of the lamp in relation to the subject, independent of the camera's position."

While in full agreement that this ability to move the position of the flash bulb away from the camera itself is a great advantage, permitting the firing of as many as three flash bulbs in various positions in relation to the subject and in perfect synchronization with the camera shutter, this department does not subscribe to the implication that the flat lighting resulting from having the flash next to the camera need necessarily be hard. It is all a matter of proper exposure, the accompanying illustration being proof of this. While the lighting is flat, it is not hard, and the modeling in the face is adequate. A small flash bulb was used.

Contrasts

WHEREVER there is contrast, there is human interest. The biggest and the smallest, the youngest and the oldest—the world never tires of hearing about them. Likewise, when a full grown man of normal



The long and short of it

height dances with a midget woman, the camera shooter sees a chance for an unusual picture and fires away.

Try thinking of the various contrast subjects that might be included in a collection of such pictures. For example, a baby's hand in the palm of a large-handed man, a dog and a horse with heads together in quiet "conversation," a midget automobile next to a huge truck, perhaps with the driver in the one "barking" up to the one in the other.

Negative Humidor

A STORAGE box for safe-keeping of films is the Mirotex Universal Humidor designed to store 162 rolls of 35-mm film and other film roll sizes up to and including the No. 127. It is made entirely of steel, is completely humidified and vented, is finished in black crackle, and is provided with a safety two-key lock. It has a leather handle.

Illumination for Copying

FOR even illumination of a photograph or manuscript or any other flat object for copying purposes, there must be a light on each side of the subject, each of an intensity equal to the other. However, this department has had the experience of using but a single light source and that to one side only in

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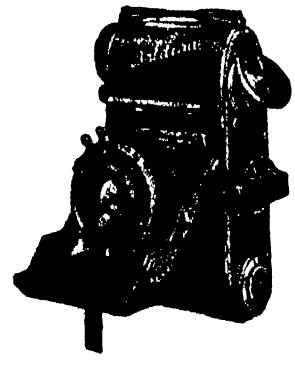

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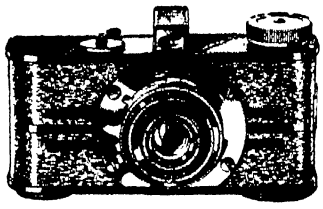

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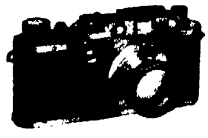

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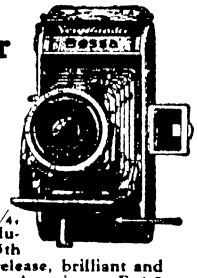

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copying a glossy print. The light used was the Ventlite, the distinctive characteristics of which are an oversize reflector and a so-called deflector, a cup-like affair in front of the light bulb, which throws the light back into the reflector and then out again. This results in throwing out four wide swaths of graduated light intensities, strongest in the center and weakest at the extreme edge. By shifting the position of the reflector so that the second band of light from the last covered the picture being copied, an even illumination was obtained of sufficient intensity to make a perfect copy.

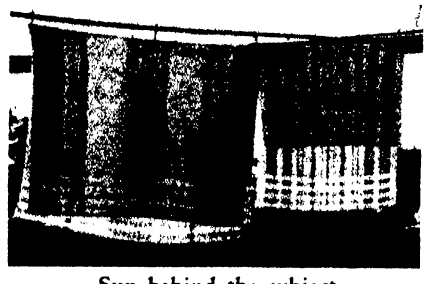
For Color Workers

THE Omag Trichromatic Separation Filters set into a special holder which brings each of the three filters, red, blue, and green, into position as needed, should prove quite attractive to users of the Leica who are interested in color photography. The filters are made from either solid-colored optical glass or gelatin. To permit the use of the special holder with standard orthochromatic and panchromatic filters for general photography, the filters are interchangeable.

Translucence

FOR recording the finest detail in photographing translucent subjects the best lighting is, contrary to the general photographic rule, that which is placed behind the subject. If front lighting must be used because certain parts of the subject are opaque or semi-opaque and will not photograph by transmitted light alone, the front light should be considerably weaker than that behind the subject though, of course, sufficiently strong to do the job.

A perfect subject in this connection is a lettuce leaf. In order to get an impression



Sun behind the subject

Lettuce leaf

1001 Ideas for the Amateur

You NEED

NEW WAYS in PHOTOGRAPHY

by Jacob Deschin. The photography expert of *Scientific American* assembles all the latest information on methods, technic and equipment, sparing needless expense of time and money for those who want to learn one of today's most fascinating hobbies. Trick photography, angles, "candid" shots, screens, color, retouching—all branches are covered in a lucid and practical fashion.

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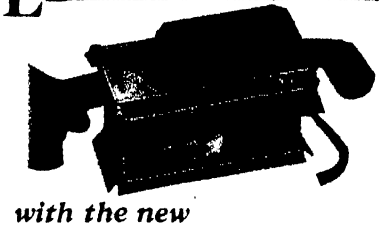

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of a section of the leaf so as to reveal the variety of vein thicknesses and shapes, ranging from almost thread-like lines to the quite thick ones, the latter suggesting tree branches, a short-focus lens was used, permitting focusing quite close to the leaf. The leaf was on a plane with the surface of the lens in an attempt to get as near over-all sharpness as possible and the only light used was that directed through the leaf.

The picture of the hanging towels was made as the sun was setting directly behind the towels.

News Pictures

PICTURES intended for reproduction in newspapers or feature articles in popular magazines have a journalistic flavor about them which puts them distinctly in a class of their own. While a fine technical and almost pictorial result is often achieved

"Coin Collector"

by the news cameraman, in general he is little concerned with such points as good composition, perfect technique, and so on. Often he must shoot and run away; more often he must shoot before the subject gets away. There is no time in such situations for the fine points of photography. Get the picture, is what the editor said, and get the picture he must if it's the last thing he does. Sometimes, however, this same photographer is sent on a so-called feature assignment and we know from the work he turns out on these occasions that he does, after all, know a good deal about what makes a good picture.

An example of the feature type of picture is the coin collector here illustrated holding a couple of ancient Asiatic coins. The picture was used to illustrate a popular article on coin collecting. Having the man hold the coins was a happy thought since a mere photograph of the coins themselves would not have given the idea of size.

Photographing Sculpture

A SCULPTOR who had some trouble in finding a photographer who could light his bust of Greta Garbo in such a way as to reveal the modeling in the face finally came to this department with his problem.

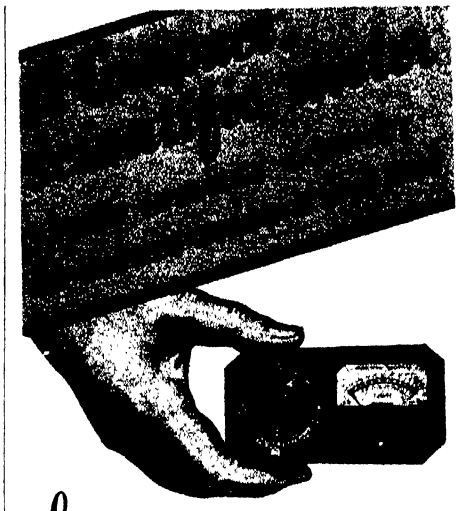
Sculpture photography

The result was the print here reproduced. A single light was used, well diffused and placed alongside the camera. Soft highlights strategically distributed gave shape and roundness to brow and cheek, nose, lips and chin, neck line, throat and shoulders. Photographing sculpture need not be any more difficult than any other type of photographic work if the subject is correctly lighted.

For Table-Toppers

IF you have been looking for a new way to create figures for your table-top pictures, try the newest kink in the amateur sculpture line—that of newspaper sculpture. This consists of moistening yesterday's newspaper and using it for modeling "clay." Very little artistic ability is necessary to turn wetted strips of newspaper into such things as knights or Indians or humorous figures and fitting them neatly into an original table-top set-up. In addition to the wetted newspaper, the other principal article required is a piece of wire, which after being bent to the desired "skeleton" form is then "clothed" with the wet paper molded to the required shape. Afterward it is "dressed" with colored "construction" paper or ordinary white paper and painted. Finally, the whole thing is shellacked.

Table-top figure under construction



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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 349)

of the way and all lands are in producing condition, it is estimated that the potential annual growth for the region will be 8,000,000 cords. This, of course, can be accomplished only if the lands that are logged are kept productive and if fires are controlled. The more intensive the forest management, the better and larger the future forest crop will be."

Flexible Glass

AIRPLANE constructors tell us that they have found a flexible glass which can be used for windshields in any form desired without impeding vision.

Airplane fuselages have failed of real streamlining because of the windshield. An abrupt line to the windshield may double the air resistance of an otherwise beautifully shaped body. With the advent of flexible glass, we may expect windshields to blend completely into the rest of the craft. We know of at least two commercial airplanes now being constructed which will make use of this new material, and no doubt there are others.—*A. K.*

Aerial Fox Hunting

THE National Aeronautic Association now encourages curious air games by issuing special kits of instructions, badges, sets of clues, and the like.

Here is how sportsmen pilots play the game of Fox Hunting in the air:

One plane is designated as the "fox" and takes off 15 to 20 minutes ahead of the others. Each pilot has a map of the territory over which the hunt is to be flown, divided into sections, each section being given a characteristic symbol. The "fox," before leaving tells the contestants which section he will fly to first. He may land anywhere in this area and lay down a cheese cloth symbol, thus indicating which section he will fly to next. The problem is to find these symbols, follow the "fox," and fly close enough to his plane to be recognized by him. The first pilot to do so is the winner, but to claim the prize he must submit his map, a duplicate of that which the "fox" used, showing the correct location of every symbol left by the "fox." The hunt is usually flown over a territory of about 20 miles square.

Other games with self-explanatory titles are: Treasure Hunt, Aerial Golf, Scavenger Hunt, and Hare and Hounds. Apparently sportsmen pilots get lots of fun out of these curious and novel games.—*A. K.*

Conquest of the North Atlantic

THERE is immense activity in preparation for the heavier-than-air conquest of the north Atlantic. There are, first of all, recurrent and apparently reliable reports that Pan American in conjunction with the British Imperial Airways are soon to put into operation transatlantic and New York-Bermuda airlines.

The tests of the Short Brothers *Empire Flying Boat*, to be employed by Imperial Airways, have just been completed. Hitherto the British have built excellent, seaworthy and airworthy flying boats, but they have been clumsy in appearance, biplanes with many struts and wires, and rather slow in speed. The photograph shows that British designers have now profited by the example of the Martin and Sikorsky *Clippers*. The *Empire Flying Boat* is just as "clean" as the American products. It is of all metal construction of the high wing, internally braced type, with wing tip floats. Fully loaded they will weigh nearly 18 tons. The normal pay load including crew will be between 3½ and 4 tons. The Pegasus air-cooled engines, rated at 740 horsepower, are supercharged, provided with variable pitch propellers and the N.A.C.A. cowl. Each boat will be equipped with all modern navigational instruments, including the Sperry Gyropilot. The normal cruising range is only 800 miles, which is considered adequate for the short stages contemplated.

In the fore part of the hull there are two decks, the upper of which is the control room for the Captain and the First Officer. Immediately behind this is the radio station, and further aft the mail hold. Mail will be dealt with in flight. The "Promenade Saloon," as the English call it, is shown in one of the photographs and is also remi-

The Promenade Saloon in the new *Empire Flying Boat*

Empire Flying Boat ready to take off on a trial flight

niscent of American flying boat practice.

Another British plan for the north Atlantic is to load a land plane very heavily and to catapult it for the start of its north Atlantic flight. The catapulting, of course, is to permit the carriage of the immense amount of fuel necessary for non-stop operation.

We have already referred to the "composite aircraft" in these columns but with very little detail. The composite aircraft is now reaching completion. The upper component will be a two-float seaplane powered with four 350 horsepower engines. The lower component will be a large flying boat, like the *Empire Flying Boat*. Altogether there will be eight engines in use with a combined power of 5000 horsepower. All the experts seem to agree that there will be no difficulty either in the launching of the "composite aircraft" or in the subsequent flying of the detached upper seaplane component.—*A. K.*

Portable Air Traffic Light

SUBSTITUTED for the old flagging system at Logan Field, Baltimore, Maryland, shortly before the flood, the portable traffic light shown in our illustration has seen continuous duty since. When flood conditions forced commercial, Army, and Navy plane operations from Washington, D. C. to Baltimore, the portable signal proved useful day and night.

Traffic signal for flyers

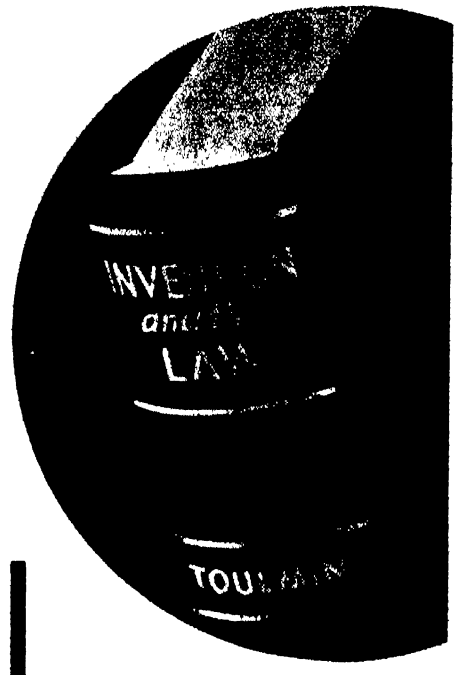
A powerful beam is cast by the light operated by the pistol-like triggers. With the triggers, the operator may signal with red, green, or white light. As a white light, it may be used as an ordinary searchlight. As a green or red light it keeps the plane in the air until the field is clear for landing. It is also used for directing the planes in taking off.

A Controllable Cowling

AT take-off, the speed of the airplane is slow, yet the engine is operating at full power and requires all the cooling air it can possibly get. At cruising the engine is operating at only 75 percent of full power, but the air streams past it at 200 miles an hour. The ordinary fixed cowl is apt to give insufficient cooling at take-off, therefore, yet produce too much drag or air resistance at high speeds.

Engine cowl that is adjustable

On the British engines, the Mercury and Pegasus, this difficulty is met by using a controllable cowling, the rear part of the cowling as shown in the photograph, being movable in and out. An endless chain operates a screw mechanism, and can set the rear cowling flap at zero or as much as



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30 degrees to the surface of the main cowl. The outlet is decreased or increased in area accordingly. Thus the pilot can secure more air in starting up or can close down the cowl and increase the aerodynamic efficiency at high speeds.—*A. K.*

Catapults to Have Wider Use

THE weight of an airplane divided by the area of the wings is termed by engineers the loading per square foot. In pioneer aircraft this loading was of the order of five pounds per square foot; now the figure has risen to as much as 30.

Why this increase in surface loading? Because greater loading means either higher speed or the ability to carry a more useful load in the form of gasoline, passengers, and so on.

To fly non-stop across the Atlantic, to increase the commercial payload, designers would like to increase this wing loading still more. But there is a limit to the increase, because the speed necessary for take-off goes up with the amount of load carried by the wings. Eventually the ship is so heavily burdened that it will not take off satisfactorily. Its excellency in the air is then purely an academic conception.

Perhaps the catapult will come to the rescue, shooting the heavily loaded craft into the air, and once in flight it should be able to take care of itself.

Catapults have been used for many years by the navies of the world, for launching fighting planes from the limited deck space of battleships or cruisers. The German Lufthansa has used them in commercial work over the south Atlantic. Now the signs of the times indicate that the use of the catapult is likely to become much more widespread.

Thus quite recently the Lufthansa gave New Yorkers a striking demonstration of the catapult at work by launching two seaplanes, the *Aeolus* and the *Zephyr*, each weighing 14 tons, from the mother ship, the *Schwabenland*. The launchings were carried out successfully on Long Island Sound.

In American catapults the explosion of gunpowder is frequently the actuating medium. In the *Schwabenland* catapult, compressed air is employed. The air is compressed in a tank at more than 2000 pounds pressure, and is released at variable pressures into a 15-foot cylinder. The piston moving in the cylinder actuates the catapult by means of two cables connecting the sliding cradle of the catapult to the piston. The pressure is kept continuously under control, so that the acceleration is kept from reaching too high a value. These huge seaplanes travel only 150 feet on the cradle but reach a speed of at least 85 miles an hour and leave the mother ship without the slightest tendency to downward movement.—*A. K.*

Flying at a Dollar an Hour

THE Cub Flyers are employees of the Taylor Aircraft Company. Taking advantage of the fact that their company builds an inexpensive, easily maintained, low-powered plane, ten workers in the plant organized a flying club. Membership increased overnight. At present over seventy members have soloed. Their ship never misses a day in the air, and one week flew a total of 163 hours. The engineers and mechanics are enthusiastic about their sport, which is also their vocation, and at lunch time it is not uncommon to see a welder drop his torch, grab his lunch box, and complete his noon day meal cruising at 3000 feet. But the most extraordinary thing is that it costs the club members only a dollar an hour to fly. Of course this group has exceptional opportunities for reducing costs. But it is not unreasonable to believe that even a group entirely unconnected with the industry could operate on similar lines, at a cost of say two dollars an hour. Private flying today need not be so very expensive for people who know how and are willing to co-operate.—*A. K.*

Automatic Landings by Radio

BLIND landings by the use of instruments are not new and their technique has been fully described in these columns. But pilots seem to over-control when making instrument landings. A new system has now been developed by United Air Lines, in

Antenna for automatic landings

which a combination of the automatic pilot and radio control has resulted in landings of wonderful precision and smoothness. A series of 250 tests has been highly successful.

The system consists of two radio beams. One is a directional beam sent out by a special transmitter operating on 232 kilocycles. This is the runway marker beam which is narrow—only five feet wide at the landing circle at the middle of the airport, and only ten feet in width at the boundary of the field.

The second radio signal is the landing beam sent out from a transmitter operating on 93,000 kilocycles. This is a curved beam following the normal gliding path of a transport plane. The beam is transmitted along the runway, gradually curving upward until it is 60 feet above the ground at the border of the field.

A special antenna is used on the nose of the transport for reception of these signals, as indicated on the photograph. On the instrument panel of the plane is a special device which has two needles, one vertical and one horizontal, operated by the electri-

cal impulses from the directional and landing beam stations. The vertical needle registers the location of the plane with respect to the runway markers beam, while the horizontal indicator records the position with respect to the curved landing beam.

The pilot preparing to make an automatic landing intercepts the landing and runway beams at an elevation of approximately 1000 feet, at a distance of five miles from the airport. After he has so maneuvered the plane that it is exactly on the landing and runway beams as indicated by the two needles, the flier throttles down to a speed of approximately 80 miles an hour and then turns over the controls to the automatic pilot. The human pilot now takes his hands and feet off the controls and concentrates his attention on the instrument with the two pointers. Occasionally he adjusts a knob on the automatic pilot control, if the needles indicate deviation from the prescribed course. Otherwise the device does all the work. The transport follows the curved beam which gradually flattens out as it approaches the runway, and the plane comes down and makes a perfect two-point landing with tail up. Then it is up to the pilot to apply the brakes, just as soon as the tail wheel also touches the ground.

This combination of radio guidance and automatic pilot is truly a remarkable example of modern applied science.—*A. K.*

British Air Progress

GREAT BRITAIN is meeting Germany's effort in the air most energetically. Planes are being built by the hundreds, and it is reported that fighting ships *in production* will have a high speed in excess of 300 miles an hour. In one particular aspect of military aviation the English probably lead the world; namely, in their robot airplanes, controlled from the ground by radio (as already described in these columns). For the time being, these robot planes are not being built for the romantic task of bombing the enemy without risking a pilot's life, but for the more prosaic, useful task of serving as target planes. No other air service has available a moving target of this type, and its value in aircraft training is indisputable.

Hitherto the surface vessels engaged in controlling the flight of robot airplanes have been any available cruisers fitted with the special radio apparatus required. The system worked admirably when the number of pilotless target planes was limited and firing practice comparatively rare. But an increase in numbers of such targets, and more time devoted to anti-aircraft gunnery, have made imperative the use of a special mother ship. This will be the *Argus*, an obsolete aircraft carrier, which will carry special gear for launching and salvaging the robots.

In another item of English news, we find a description of well equipped ambulance planes. Besides medical stores, oxygen tanks, and so on, these planes carry an oxygen tent consisting of a collapsible expanse of airtight sheeting which can be lowered over the patient's head and shoulders, and also a blood transfusion apparatus. Curious additions to flying equipment!

One of our photographs shows a recent addition to the British air forces—the Westland "army co-operation" monoplane. Compartments for both pilot and observer are carefully enclosed. The pilot is placed above the wing to have ample vision in front. Cockpits are as carefully heated and as comfortably arranged as in commercial airplanes. Gone are the days when fighting pilots were fully exposed to the airstream. The Westland carries both the Handley-Page slot and the flap.—*A. K.*

Selling Air Transport to the Public

THE business of the airlines grows both steadily and rapidly. We have often had occasion to comment on the wonderful technical developments which are a partial explanation of this growth, but the airlines are also making a strong, conscious, and continuous sales drive to secure more customers.

They are particularly anxious to get a man or a woman into the air for the first time. Some people just cannot decide about this. One business man closed an argument about taking a first flight by saying: "Young man, I would feel about as secure in an airplane as an elephant hanging head down over a cliff with one leg tied to a daisy." Accordingly "first fliers" are sought in every possible way just as "first voters" are the object of special solicitude by politicians.

Airline executives endeavour to dispel the notion that pilots are intrepid explorers. They are not. They are just good pilots, with fine mechanical knowledge of their planes and engines.

Every important city in the United States now boasts an airline ticket office. Young men are selected for these offices and for outside promotion work with the greatest care, and are given a two months' schooling in the Reservations Department.

In line with this policy, pilots must be fairly young, good looking, and courteous. We have heard a great deal of stewardesses. Now stewardesses are to be displaced by

A new army monoplane used by the British air forces

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stewards, and these men are to be as good as stewards on a crack ocean liner.

The attitude of the insurance companies in regard to life and accident policies of air travelers was at one time exceedingly hostile. By statistical studies and by frequent papers read before insurance societies, the aviation people seem to have proved their point to the satisfaction of the insurance men. Thus D. T. Harvey, Vice-President of the Massachusetts Indemnity Insurance Company, recently wrote as follows:

"Concerning the comparable hazards of the various modes of transportation available to-day, this company has, on a basis of experience, promulgated a ruling that executives or salesmen traveling by air on regularly established air lines are to be classified as 'A,' whereas executives or salesmen traveling by automobile are to be classified as 'B' risks."

Such efforts, among others, are legitimate and evidently efficacious.—*A. K.*

80 PERCENT FORECASTS

CONTRARY to general opinion which holds that the weather man is nearly always wrong, he is right over 80 percent of the time in forecasting the weather, according to Dr. J. H. Kimball, meteorologist in charge of the Government's bureau in New York.

A Shortage of Skilled Airplane Workers?

WE are credibly informed that there is actually a shortage of skilled mechanics in airplane factories. This is understandable because the Army and Navy are placing large contracts for fighting aircraft, because the construction of private planes is growing, because traffic on the airlines is growing so rapidly that equipment has to be expanded or replaced, and finally because the work in the airplane factory is of a highly specialized character. In what other industry have so many minute rivets to be inserted? Where else is sheet metal of such minute thickness placed over large areas? Where else, in big construction, is so much accuracy needed? Where else does safety depend so much on skilled workmanship? To meet this shortage—which may be only temporary, young men should be warned—trade schools all over the country are giving attention to aircraft handiwork, and many high schools are giving vocational courses in this field.—*A. K.*

Can Science Save Civilization?

WHEN an entomologist looks at an ant-hill and writes learnedly and interestingly about what happens in that insect community, that, admittedly, is science. But when social workings of a nation or the world are viewed with a critical, scientific mind, the cry is likely to arise: "That's not science."

Physicists, chemists, and biologists have been reluctant to admit economics, political theory and practice, history, and sociology into the category of "science." But an increasing volume of scientific voices has warned that those who give new command of natural forces have an obligation to see that research is put to socially safe uses.

An eminent British man of science, Sir Richard Gregory, Bart., editor of *Nature*, is the latest to urge that "it is the duty of men of science to assist in promoting more worthy uses of the new powers they are continually placing in the hands of the community." Otherwise the world seems likely to be reduced to "a place of dust and ashes."

"The impacts of science with society are now so numerous that scientific studies in the realm of social biology are even more necessary for civilized life than researches in the physical sciences," Sir Richard contends.

"It is an ironical comment upon modern civilization that the social reaction to the gifts of plenty made possible by the progress of scientific knowledge is not a corresponding increase of human welfare but distress and unemployment and the prostitution of scientific effort to purposes of destruction.

"In so far as science has brought about increased control over the forces of Nature, it accepts responsibility for these conditions. It insists, however, that such deplorable consequences are not essential, but are due to the neglect of the application of scientific methods to the solution of social problems.

"Our distributive and economic system

remains on the basis of a pre-scientific age, wholly unadjusted to the needs of a changing world, and unable to bear the burdens placed upon it by the problem of new and almost incredible abundance.

"Science can provide the world with everything required for the maintenance of a growing population in a rising standard of comfort; but there are no accepted principles for the right use of the new powers, and international agreements are mainly adjustments of national interests conceived in confined political atmospheres and determined by expediency. While this spirit prevails, the prospect of finding a formula which will unite civilized peoples for the general well-being of humanity seems almost hopeless.

"A regenerative influence is required to save civilization from disaster, and the mission of science in the changing world of today should be to introduce it into the field of social biology, and thus enable us still to believe in the highest destiny of man." —*Science Service.*

PARSEC

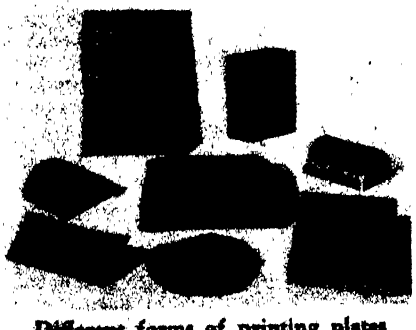
WHEN astronomers speak of a parsec, think of it as 3.26 light years or 200,000 times the distance from the earth to the sun or 20,000,000,000,000 miles—any one of them will do. And don't get dizzy if a star is said to be distant one megaparsec—a million parsecs!

Synthetic Rubber Printing Plates

MADE of an oil-proof, moisture-proof synthetic rubber that can be vulcanized and processed just as natural rubber is, a new type of printing plate has been developed and placed on the market which is said to have marked advantages over the rubber plates now in use.

The synthetic rubber, known under the trade name of "Thiokol," has been successfully used for blankets for newspaper presses and, outside the printing industry, for gasoline hose and tubing, gas cells for lighter-than-air craft and cable sheathing. It comes in sheet, liquid, and powder form. Plates made of it are said to be completely impervious to the action of the chemicals contained in printing inks and to gasoline, kerosene, and other washes.

Other advantages claimed for the plates are that they materially reduce the time required for makeready as compared with metal plates, use anywhere up to 50 percent less ink, practically eliminate offsetting and the need of slipsheeting, are senstive on the press, print detail sharply and clearly, wear longer than rubber plates, do not swell or deteriorate on exposure to air, chemicals, or moisture, and do not squash. They can be used for the same types of printing as plates made of natural rubber, including posters, folders, broadsides, catalogs, cutouts, and so on.



Different forms of printing plates made of synthetic rubber, and, center, a pile of the raw material used

A curved synthetic rubber printing plate, and an example of its work

The "Thiokol" plates can be molded from type forms, line engravings and halftones of up to 120 line screen. They can be mounted on either wood or metal base—a laminated wood base is recommended for most purposes—and can also be furnished glued to a metal back for use on patent base in the same way as 11 point electrotypes. They have been used for both flat and curved plates as shown in the illustrations.

In making "Thiokol" plates a sheet of matrix board, previously heated, is placed over the type form or engraving, very much as in the making of a stereotype matrix. Over this in turn is placed a thin sheet of tin, brass or steel to prevent the matrix from sticking to the top of the press, pressure is applied, and the matrix is taken from the form and cleaned off for plate making.

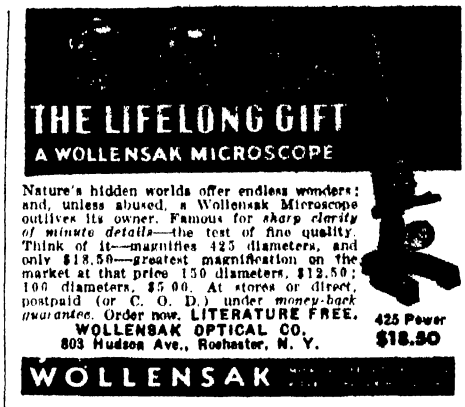
A "charge" of the "Thiokol" in powder form—as much as is needed to make the plate—is then spread over the matrix, pressure is applied again, usually in a hydraulic press, and in about six minutes the plate is made. After trimming and mounting, it is ready to put on the press. Thirty-five minutes, it is stated, is liberal time for making a plate from start to finish.

Printers having equipment for molding rubber plates can use it also for molding "Thiokol" plates. For those who do not, it is necessary to ship their original forms to "Thiokol" plate makers.

Freezing to Death is Fun

SIR JOSEPH BARCROFT, one of the world's leading physiologists, described at Yale experiments to which he had subjected himself in order to find out what happens to the mind in the early stages of freezing to death. Speaking on the Dwight H. Terry Lectureship, Professor Barcroft, who is professor of physiology at Cambridge University, told how he had deliberately lowered his temperature to a point approaching unconsciousness.

"What comes back when I recall the attempt to reduce my body temperature?" he said. "Certain effects on the heart were interesting but in no way arresting, but what comes back is the effect on my mind. There was a moment when my whole mental outlook altered. As I lay naked in the cold



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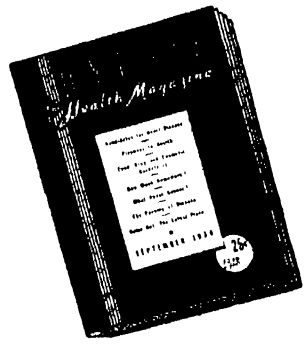
YOUR HEALTH

How Much Do You Really Know About It?



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TEACHERS and STUDENTS find in HYGEIA a wealth of live material on medical science, anatomy and physiology, and the principles of healthful living. Also, especially for them, Dr. J. Mace Andress conducts the "School and Health" Department.

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room I had been shivering and my limbs had been flexed in a sort of effort to huddle up, and I had been very conscious of the cold. Then a moment came when I stretched out my legs; the sense of coldness passed away, and it was succeeded by a beautiful feeling of warmth; the word 'bask' most fitly describes my condition: I was basking in the cold. What had taken place, I suppose, was that my central nervous system had given up the fight, that the vasoconstriction had passed from my skin, and that the blood returning thither gave that sensation of warmth which one experiences when one goes out of a cold-storage room into the ordinary air. Perhaps I can express the change which took place in another way.

"Up to the point at which shivering ceased, nature fought the situation; my instinct was to be up and about, an effort of will was necessary to remain the subject of the experiment; after that point I gladly acquiesced, initiative had gone. Doubtless a second and more advanced stage would follow in which inertia would lapse into unconsciousness. For I suppose that, had the experiment not ended at that point, my temperature would have fallen rapidly and I was on the verge of the condition of travelers when they go to sleep in extreme cold never again to awake."

OIL—COAL

THE nation's visible oil supply would cover the state of Ohio with a pond three quarters of an inch deep; the total supply of coal in the country, if spread over the same state, would be 76 feet deep.

Grasshopper Bait

USE of odors to attract insects to eat poisons prepared for them has been shown to be effective in controlling many types of insect pests. Cotton boll weevils are attracted by certain organic amines, and the Japanese beetle can be lured into a trap with geraniol, the principal constituent of the odor of geranium. The latest addition to the list is the use of amyl acetate (sometimes called banana oil) to attract grasshoppers. The following mixture has been suggested as an effective poison for grasshoppers: bran, 100 pounds; salt, 5 pounds, sodium arsenite, 1 pound; molasses, 2 gallons; water, 6 to 8 gallons. After thorough mixing, 3 ounces of technical amyl acetate (technical grade is preferred because of its stronger odor) are added and the mixture broadcast or spread where grasshoppers can get it. This mixture is said to be sure death to grasshoppers.—*D. H. K.*

Aluminum Mail

FIFTEEN THOUSAND aluminum rings went into the making of an actual reproduction of the armor worn a thousand years ago by the Vikings. This modern Brynje (ring armor) was made by Otto Goetzke, vice president of Church & Company, jewelry manufacturers. It is believed to be the only complete costume of its kind in existence. It took three years of part-time work and an infinite amount of patience to complete it. The reproduction weighs only five pounds, whereas its iron equivalent would weigh 15 pounds.

Chain mail made of aluminum rings

Mr. Goetzke says that the only point in which his armor differs from that of the Vikings is that he did not close the rings, while the Vikings overlapped their rings and joined them together with rivets.

New Rôle for Chlorophyll

THAT chlorophyll, the green pigment usually associated only with the leaves of plants, is found also in lettuce seed and may be the agent through which light stimulates germination of light-sensitive seed, has been discovered by Lewis H. Flint, Bureau of Plant Industry, United States Department of Agriculture, and E. D. McAlister, Division of Radiation and Organisms, Smithsonian Institution.

Thus it is believed that the chlorophyll not only is important in the manufacture of plant food in the leaf, but also plays a big part in germination due to its sensitivity to light rays.

A little more than two years ago Flint discovered that certain lettuce seed which failed to start growth under ordinary conditions would germinate in 24 hours if soaked for an hour or longer and exposed to sunlight or the proper kind of artificial light.

First the physiologists adopted the practice of soaking the seed before making the germination test. This seemed to help in breaking the dormancy. In the soaking process seed was generally exposed to a diffused light for a short time. This suggested that light might have something to do with the germination.

Subsequent tests showed that light did play an important part in starting the seed growth. First light tests were made with an ordinary Mazda lamp and the seed was exposed for 10 minutes. Results were easily noticeable when 100 minutes of soaking and 10 minutes of light exposure gave 90 percent germination in seed that would not germinate at all in darkness.

Exposure to direct sunlight for four to 60 seconds produced the same effect, and it became of interest to find out which rays of light were producing the effect.

Flint continued his tests along this line by "breaking" a light ray into its component parts, ranging from the ultra-violet short rays to the infra-red long waves. The lettuce seed was tested under the various light wavelengths to determine the germination trends from this standpoint.

Results were fairly uniform inasmuch as the seed showed a negative reaction to the short violet rays with the promotion of germination reaching its peak in the yellow, orange, and red, or longer rays.

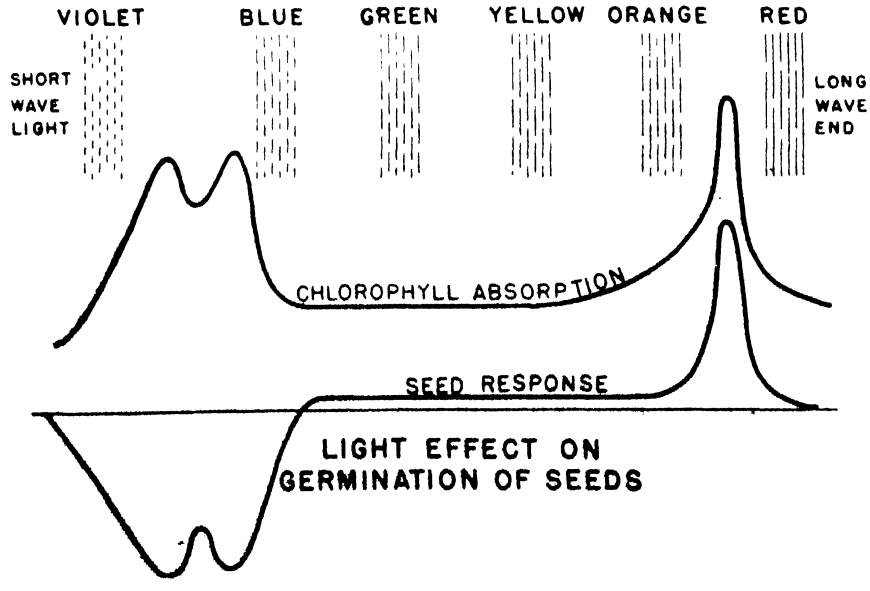
Physiologists discovered long ago that the chlorophyll in the plant absorbed large quantities of violet and blue short rays as well as the orange and red long rays as shown in the graph. The medium length green rays passed on through without any noticeable effect.

Tests with the seed showed that the absorption of the violet and blue short rays corresponded with absorption of the chlorophyll in the leaf, but that these rays had a negative or holding-back tendency in the germination tests. However, the seed followed the same general tendencies in absorbing large quantities of the orange and red rays which tended to promote germination. Also, like the plant chlorophyll, the seed response to the medium-length green rays was comparatively little.

In regard to these findings, Flint and McAlister declare:

"The close analogy between the critical wavelengths of radiation influencing seed germination and the critical wavelengths of radiation absorbed by chlorophyll and allied pigments places a distinct emphasis upon what perhaps is a new and promising viewpoint.

"With an increased interest in qualitative



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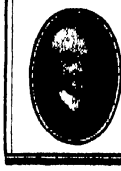

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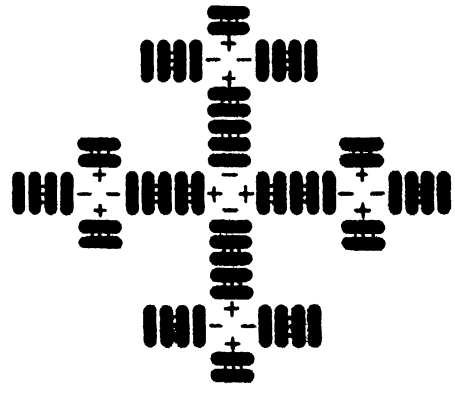

Neon atom. Each heavy line represents one vortex-ring, viewed edgewise. The neon vortex-atom consists of one central helium group and four peripheral helium groups. Its properties should therefore be similar to those of helium, which is actually the case. This perfect agreement between atomic structures and properties in the vortex theory stands out in sharp contrast to the utter lack of such agreement in the nuclear theory. Copyrighted 1933 and 1934 by Carl F. Krafft.

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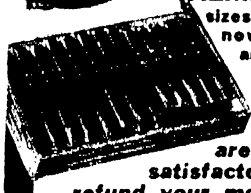

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light effects the results in this test emphasize the desirability of more adequate knowledge of the quality of light at the earth's surface and the modification of that quality with time of day and year, with altitude, and with water vapor in the earth's atmosphere."

Artificial Breeding Makes Eggs More Fertile

SIMPLIFIED methods for artificial breeding of poultry, which in tests produced higher fertility than natural mating, have been developed by poultry scientists of the United States Department of Agriculture. A 97 percent fertility of eggs was obtained by these new methods as compared with an average of 85 percent in the natural matings at the National Agricultural Research Center, Beltsville, Maryland.

The new methods make it possible to fertilize more than a hundred hens daily from the semen of a single rooster. It is easy to breed one to two hens a minute by the artificial method. Ordinarily, poultrymen provide a male for each 10 or 15 birds in their flocks during the breeding season.

The scientists found they could collect semen from male birds by stimulating certain nerves. The process is repeated on different males until the desired quantity is collected. In fertilizing a hen, her abdomen is pressed gently until the oviduct protrudes. A syringe is then used to put the semen into the oviduct. Two or three drops of undiluted semen injected daily into a hen are sufficient for maximum egg fertility. Previously, hens have been bred artificially by collecting the semen a male has deposited in the oviduct of one hen and transferring it to other hens.

With the new procedure, hens in battery plants can be inseminated without transferring them from their laying quarters. Otherwise, it is necessary to remove the hens from their laying batteries to floor pens or other quarters for natural breeding. These new artificial methods also promise to be of great value in cross-breeding experiments, especially in cases where it is difficult to get fertile eggs. Tests by the Department show that natural mating almost never produces fertile eggs when either the female or the male is four times as heavy as its mate.

HEAVY FOOD

OLD Mother Earth is putting on weight at the rate of nearly a pound an hour, on a diet consisting of stone and iron. This material comes in the myriads of shooting stars which enter the earth's atmosphere every 24 hours.

1,000,000 Volts

THE accompanying illustration shows the 1,000,000-volt, direct current, electrostatic generator designed by Dr. John G. Trump of the Massachusetts Institute of Technology for the Huntington Memorial Hospital in Boston, where it will be harnessed to a huge X-ray tube for the production of high voltage short waves of great penetrating power for the treatment of malignant diseases.

The new generator is expected to be

High-voltage electrostatic generator

capable of producing a greater intensity of gamma-type rays than the combined output of all the radium available for medical use. It is expected to be ready for operation late this winter.

The big cascade-type X-ray tube to be used with the generator will be made up of 20 porcelain sections about 12 inches in diameter with diaphragms between each section to focus the stream of high-speed electrons in their passage from the upper end to the gold target at the bottom. The treatment room is directly under the generator and will be equipped to accommodate as many as three patients at once.

Honest Weight

VERIFICATION of the honesty of heavy duty scales has occupied the minds of Government officials in many places this autumn. The state of Pennsylvania has bought special equipment and announces that it will check every big scale in the state. The National Bureau of Standards reports that it is going over every Federal scale. Other communities which operate special trucks with test weight equipment include the District of Columbia, the City of New York, and the State of Massachusetts, according to a report of the Autocar Company, whose weight-testing truck appears to be standard and is used by all the above authorities.

Sleet Danger

A SOLID wall of frozen sleet on the windshield is a winter driving peril most car owners vividly remember. Special fans, heaters, flexible tubing to direct the car heater output against the glass, chemical solutions, and so on have been used to combat this hazard with varying success.

The newest sleet-removing device, called Sleet-Master, is a spare wiper blade, to hook on in a second, in place of the regular rain blade, whenever sleet strikes. It both melts the sleet and wipes the windshield clear. Entirely self-contained, it requires no connections, puts no load on battery or motor. It comes complete with two refills made of salt and an ingredient which retards the tendency of salt to dull car finish.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

SHARP FOCUS AND ACCURATE EXPOSURE, by Dr. W. Kross, is a little 46-page book for the amateur photographer who is particularly interested in obtaining the best possible results with his camera. Illustrated with photographs and drawings pertinent to the text. *American Photographic Publishing Co., 428 Newbury Street, Boston, Mass.—40 cents.*

MORE GOODS FOR MORE PEOPLE is a 13-page booklet discussing the tremendous part played by invention and the mechanization of factories in solving the problem of raising the standard of living of the American people. *Write for Bulletin 1236A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

RESONANCE AND ALIGNMENT is a 91-page book, board covers, written for the radio service man. It covers briefly and succinctly, with pertinent illustrations, the subjects of the title as applied to modern radio maintenance. *John F. Rider, 1440 Broadway, New York City.—60 cents postpaid.*

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LIST OF INSPECTED HOUSEHOLD ELECTRICAL APPLIANCES is, in main, a tabulation of all types of electrical equipment, giving the names of manufacturers of approved appliances so that they can be readily identified. *Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill. Gratis.*

RESEARCH . . . AND IMPROVED EQUIPMENT tells the story of present-day Pullman cars, for steam, electric, and Diesel operated trains, as well as other rolling stocks developed by the Pullman-Standard Car Manufacturing Company. *Write for Bulletin 1236C to Scientific American, 24 West 40th Street, New York City. 3-cent stamp.*

COMMON MUSHROOMS, by Leon L. Pray, describes and illustrates a number of the most common and conspicuous mushrooms of the United States. Enough information is presented to enable a careful observer to distinguish the more important species. A bibliography on the subject is also given. *Field Museum of Natural History, Chicago, Ill.—50 cents.*

RAINFALL INTENSITY-FREQUENCY DATA presents tables and maps that give the statistical probabilities of excessive rainfall in the continental United States. Prepared by Dr. David L. Yarnell, of the Bureau of Agricultural Engineering, it is of particular value to engineers and students of weather. *Superintendent of Documents, Government Printing Office, Washington, D. C.—10 cents coin.*

THE STORY OF FIRE is a small pocket-size booklet which tells of man's use of fire from the Paleolithic Age to the present day. *Write for Bulletin 1236D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

NEW YORK ADVANCING; A SCIENTIFIC APPROACH TO MUNICIPAL GOVERNMENT is in the nature of a composite report of the undertakings of all departments and boroughs of the city. It contains 358 pages plus a comprehensive index and is nicely printed with fine illustrations. *Municipal Reference Library, 2230 Municipal Building, New York City.—50 cents.*

AIR CONDITIONING AND AUTOMATIC HEATING FOR THE HOME, by Willis H. Carrier, describes and illustrates typical applications for both oil and gas fuel. *Write for Bulletin 1236E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION, 1935, contains 465 pages of selected papers on scientific subjects such as weather, astronomy, cosmic rays, electricity, vitamins, atoms, biology, fish, butterflies, flight, ancient man, archeology. *Superintendent of Documents, Washington, D. C. —$1.00.*

AIR OPERATED CONTROLLERS explains in non-technical language the principle of operation of many different types of controlling devices for use in various industrial applications. *Write for Bulletin 1236F to Scientific American, 24 West 40th Street, New York City.—Gratis.*

THE DEVELOPMENT OF THE ASPHALT JETTY FOR HARBOR PROTECTION, by Colonel F. B. Wilby, U. S. A., is an 8-page illustrated pamphlet of particular interest to engineers concerned with the protection of water front property. *The Asphalt Institute, 801 Second Avenue, New York City. —Gratis.*

GREAT FOREST FIRES OF AMERICA, by John D. Guthrie, is a plea for the prevention of forest fires, dramatized by a brief yet gripping series of reports of fires which have devastated large forest areas of the United States. Campers can help the cause by following the four rules laid down on the inside front cover of this booklet. *U. S. Department of Agriculture, Washington, D. C. —Gratis.*

FACTS ABOUT METAL POLISHING is a 40-page illustrated booklet, pocket size, that covers the subject of the title from the viewpoint of industrial polishing. It defines the various polishing operations usually employed, and then tells how they are accomplished and what types of polishing materials are to be used. Gives tables of materials. *Norton Company, Worcester, Mass.—Gratis.*

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THE AMERICAN ANNUAL OF PHOTOGRAPHY

1937—Volume Fifty-One

NO amateur photographer's library can be considered complete unless it contains the latest edition of this well-known book. Each year it contains numerous articles by authors in various fields of photography, together with full-page reproductions of outstanding photographs. This year's edition is no exception to the rule. Containing 324 pages of text, including a miscellany of formulas and hints for the photographer, it measures up to established tradition in every respect.—$1.65 postpaid.—*A. P. P.*

THE MICROSCOPE

By Simon Henry Gage, Emer. Prof. Histology and Embryology, Cornell University

OF all works on elementary microscopy this one by Professor Gage is and for many years has been the foremost, the most comprehensive and the "central" book. It is the recognized standard text and handbook. That position could never have been held since 1908 had the book not been frequently revised. This new edition is the sixteenth. The book now contains 593 text pages, 313 figures and is quite a heavy chunk of a book. Its scope is: microscopes and their parts, bright-field microscopes, lighting, experiments, polarization, optics of microscopes, microspectroscopes, ultra-violet microscopes, interpretation of appearances, magnification and micrometry, drawing with the microscope, photographing with the microscope, cover-glasses, mounting, fixing, sectioning and so on, micro-incinerations (new chapter), history of microscopes. This is neither a stiff, advanced treatise nor a light-weight book, but it gives microscope theory in terms that plain people can understand after a little study. An amateur microscopist who has no copy of Gage on his special shelf is like a man with a hole where his front teeth were.—$4.25 postpaid.—*A. G. I.*

THE CRIME AND THE CRIMINAL

By Dudley D. Shoenfeld, M.D.

WITH the subhead "A Psychiatric Study of the Lindbergh Case," this book presents many facts regarding this famous case that hitherto have not been known to the general public. The author figured largely in the apprehension of the murderer of the Lindbergh baby and followed closely the legal aspects of Hauptmann's battle for life. The book is a complete record of the crime and trial as seen by the author.—$3.65 postpaid.—*A. P. P.*

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By H. G. Wells

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THE WAR IN OUTLINE

By Liddell Hart

DISCUSSIONS of the World War are legion. The various commanders, the diplomats on all sides, the expert tacticians have all contributed their share to the flood of studies of all phases of the War. Now comes a précis of the whole affair, written by one who has been acclaimed the greatest military historian writing today in the English language. Tersely, and perhaps sometimes in language that is too sharply clipped, he gives the story of the War from "The Spark and the Powder" through to the complete collapse of Germany. For those who wish to review the War in its broader details, without the difficulty of studying the finer points of strategy, this is a most admirable book. It has the merit of brevity, being only 285 pages long.—$2.15 postpaid.—*F. D. M.*

COLOUR CINEMATOGRAPHY

By Major Adrian Bernard Klein

ALTHOUGH numerous and expensive attempts at the production of colored motion pictures have been made during the past 30 years, it is only very recently that the changes in technology have made possible colored films that may be considered at all satisfactory. Even present-day films have occasional and very noticeable defects. This does not detract, however, from the credit due to the various workers in the field who have expended time and energy untiringly in the search for success. The present book, after an historical summary, explains the technical basis of colored motion picture photography and describes, in complete detail with pertinent illustrations, the various systems in use today. —$7.20 postpaid.—*A. P. P.*

DYKE'S SELF STARTER

By Warren A. Taussig

USED in connection with that grand old book "Dyke's Automobile and Gasoline Engine Encyclopedia" (17th Edition), the present book is a "self-instructor" on the subject of automobile engine starting devices. In the first section of the book is a series of questions with direct references to the Encyclopedia. Then follows a repair section and a series of special answers to the questions in the first part of the book. This book is of no value to the reader without the Encyclopedia.—$1.40 postpaid. —"Dyke's Automobile and Gasoline Engine Encyclopedia"—$6.50 postpaid. —*A. P. P.*

CRIMES OF THE HIGH SEAS

By David Masters

"THE scuttler may trap himself with his own lies." This statement by the author seems to be the keynote of the success of Admiralty Courts in defeating the purpose of those who scuttle

ships for their insurance. This is one phase of the romance of the sea which, while it makes most interesting reading as this author presents it, has never reached the public in sufficient detail to show the prevalence of such crookedness. Mr. Masters, who has formerly written for Scientific American, has collected from official records the case histories of a large number of such crimes, some of which date back for many decades. He shows that shipping men, when they do plan such a crime, are equally as thorough in their scheming as are the crooks in the detective magazines of today. We recommend this for all those interested in the lore of the sea.—$2.65 postpaid.—*F. D. M.*

MEDICINE AND MANKIND

By Doctors Pool, Watson, Haggard, Brooks, Draper, Kennedy, McCollum, and Carrel

SEVEN popular medical lectures given at the New York Academy of Medicine by noted physicians have been published as the chapters of this book and they make fascinating reading: How we learned about the human body; medicine in the days of Louis XIV; contributions of the primitive American to medicine; the common denominator of disease; the organic background of mind; the story of the vitamins; and the mystery of death—these are the subjects.—$2.15 postpaid.—*A. G. I.*

BEAUTY BEGINS AT HOME

By Katharine Wellman

RECIPES for cosmetics—415 of them—comprise the most important part of this book. The recipes cover full directions for making and storing such a variety of cosmetics as cleansing creams, artificial sun tan, lipsticks, hand creams, and face packs. The book tells what beauty treatments can and cannot do and how to obtain the best possible results by the compounding of preparations from pure ingredients. This appears to be no ordinary beauty culture promotion material, but rather to be grounded on the bedrock of common sense. A valuable appendix gives sources of materials and price lists.—$2.15 postpaid.—*A. P. P.*

OUR NAVY

By Charles J. Finger

ESSENTIALLY a narrative rather than an exposition, this new volume is an excellent outline history for young people. It carries through from the period of the American Navy or, rather, from 1772 when there was no such thing as an "American Navy" but only a few scattered sloops doing duty as war vessels, through to the present day. The last chapter, for example, pertains to the conquest of the air, and discusses the various airships our navy has operated since the World War, the airplanes, and the aircraft carriers. It ends fittingly: "And today . . . there are those who dream of a day when neither navy nor army will be needed; the dream is glorious, but it implies a nobler civilization than the world has ever seen."—$2.15 postpaid.—*F. D. M.*

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By Ralph Linton, Prof. of Anthropology, University of Wisconsin

AN introduction to social anthropology—race, society, the family, marriage, tribe, state, social systems, discovery, function, culture, interests, and so on. It is not a textbook, yet to the outside reader it would give the practical equivalent of an elementary college course in social anthropology.—$4.20 postpaid.—*A. G. I.*

DIGESTION AND HEALTH

By Walter B. Cannon, Prof. Physiology, Harvard Medical School

MORE scientific than general and popular is this book, which discusses the scientific problems of the nature of appetite and hunger, the nature of thirst, also digestion and bodily vigor, indigestion from pain, worry and excitement. Its style and language are easy to understand but the various problems are approached more from the point of view of causes and mechanisms than cures—which is what is meant by the statement that the book stresses the scientific side. Some interesting experiments are described.—$2.15, postpaid.—*A. G. I.*

AIRPLANE AND ENGINE MAINTENANCE

By Daniel J. Brimm, Jr., and H. Edward Boggess

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DOWN TO EARTH

By Carey Croneis and William C. Krumbein, Department of Geology, University of Chicago

TRAVELERS and motorists often wish they could interpret the striking phenomena of the rocks they see wherever they go but even they probably do not sense the fact that, for every earth feature they see which has a scientific meaning of its own, the student of geology finds a hundred others right in plain sight. Just as a traveler in Europe misses most of what there is to be seen if he does not carry along a knowledge of history, so a traveler going anywhere misses a whole realm of science by having little knowledge of geology. The present book would equip the average reader to travel with eyes that comprehend a broad and ever fascinating science. It covers all elementary aspects of geology, without jargon and in simple, attractive terms and language. It happens to be an elementary college text but is one of the newer kind designed to make students want to learn. Pleasant reading in place of drudgery. A large book of 484 illustrated pages.—$5.25 postpaid.—*A. G. I.*

BE GLAD YOU'RE A NEUROTIC

By Louis E. Bisch, M.D., Ph.D.

PRACTICALLY everybody has at least some neurotic traits. Are you oversensitive, overconscientious, unduly worried about things, self-conscious, jealous or suspicious, a day dreamer, cynical, unduly disorderly or too orderly, superstitious or cultish, easily fatigued and poorly relaxed, emotionally unstable? If you have some of these or of about 50 other kinks you are somewhat neurotic (there is no hard and fast line between normal and neurotic). But is it awful to be a neurotic? Here the author takes a refreshing tack. No, he says—be glad you're neurotic, for normal people are extremely stupid. The geniuses—great inventors, for example, or Napoleon—have all been neurotics.

The author says he is himself a neurotic. And who on earth is in a better position to understand neurotics than a neurotic? For a normal person doesn't sense what it is all about. Hence this book, by a neurotic, is a very revealing book and it ought to give half the world a basis on which to understand the other half. Persons who have had continued trouble getting along with other people ought to get a new orientation from it (and incidentally, so ought normal folks but they won't read it). There is in the book a test by which you can rate your own degree of neuroticism (or genius?). The best thing about this book is that it doesn't preach at you or try hard to get you to reform—it's more fun being a bit nutty. It has a very readable style, and is likely to have a wide sale.—$2.15 postpaid.—*A. G. I. (one of them).*

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